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WEST VIRGINIA ORDNANCE WORKS
SUPPLEMENTAL REMEDIAL INVESTIGATION
FINAL REPORT

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August 1987

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A supplemental Remedial Investigation (RI) was conducted at the second operable unit of the West Virginia Ordnance Works (WVOW). The RI summarily assessed ground water contamination at the Acids Area/Yellow Water Reservoir area, the Red Water Reservoirs area, and the Pond 13/Wet Well Area. The field effort was conducted from March 1986-August 1986. The study included the following elements:

1. Installation of nine ground water monitor wells and one water-level observation well (March 1986).
2. Sampling of 9 new monitor wells and 24 existing wells (April 1986).
3. Sampling of six sediment locations at the Red Water Reservoirs.
4. Time-series sampling of Wells GW27D and GW27 during a 48-hour pumping period (August 1986).
5. Resampling of six monitor wells and one water supply well (August 1986).

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Ground water contamination is limited to the shallow alluvial aquifer at the three areas of concern. The shallow aquifer is separated from a deep glacial outwash aquifer by a gray clay confining layer. This confining layer is present in all areas of concern at WVOW and acts as an effective barrier to preclude vertical contaminant migration.

Ground water flow in the shallow aquifer is to the west. A ground water divide exists for the deep aquifer; ground water flow is to the north (north of the Acids Area/Yellow Water Reservoir) and to the south at Pond 13/Wet Well Area.

TABLE OF CONTENTS

Section		Page
LIST OF ACRONYMS AND ABBREVIATIONS		ix
EXECUTIVE SUMMARY		ES-1
	1.0 INTRODUCTION	1-1
1.1	SUMMARY OF CONTAMINATION STATUS	1-3
1.2	SUPPLEMENTAL RI OBJECTIVES	1-5
1.3	SUPPLEMENTAL RI APPROACH AND SCOPE	1-8
1.4	SUPPLEMENTAL RI REPORT ORGANIZATION	1-9
	2.0 SUPPLEMENTAL RI FIELD PROGRAM METHODOLOGY	2-1
2.1	SITE SELECTION RATIONALE	2-1
	2.1.1 SEDIMENT SAMPLING LOCATIONS	2-1
	2.1.2 WATER-LEVEL OBSERVATION WELL LOCATION	2-3
	2.1.3 MONITOR WELL LOCATIONS	2-3
2.2	WATER-LEVEL MEASUREMENTS	2-3
2.3	WELL INSTALLATION	2-8
	2.3.1 WATER-LEVEL OBSERVATION WELL	2-8
	2.3.2 GROUND WATER MONITOR WELLS	2-8
2.4	GROUND WATER SAMPLE COLLECTION PROGRAM	2-13
2.5	SEDIMENT SAMPLE COLLECTION PROGRAM	2-20
	3.0 GROUND WATER HYDROLOGY	3-1
3.1	REVIEW OF AREAWIDE HYDROGEOLOGY FOR THE ACIDS AREA/ YELLOW WATER RESERVOIR, RED WATER RESERVOIRS, AND POND 13/WET WELL AREA--PHASE I SURVEY	3-1
	3.1.1 AQUIFER CHARACTERISTICS	3-1
	3.1.2 GROUND WATER/SURFACE WATER INTERACTION	[illegible]

TABLE OF CONTENTS
(Continued, Page 2 of 3)

Section		Page
3.2	OVERVIEW OF METHODOLOGY AND AQUIFER CHARACTERISTICS EMPLOYED IN THE PHASE II SURVEY	3-6
3.3	ACIDS AREA/YELLOW WATER RESERVOIR	3-20
	3.3.1 REVIEW OF PHASE I RI RESULTS	3-20
	3.3.2 PHASE II RESULTS	3-20
3.4	RED WATER RESERVOIRS	3-30
	3.4.1 REVIEW OF PHASE I RI RESULTS	3-30
	3.4.2 PHASE II RESULTS	3-30
3.5	POND 13/WET WELL AREA	3-42
	3.5.1 REVIEW OF PHASE I RI RESULTS	3-42
	3.5.2 PHASE II RESULTS	3-44
3.6	SURFACE WATER ELEVATIONS	3-50
3.7	SITEWIDE HYDROGEOLOGY--PHASE II RESULTS	3-53
	4.0 CONTAMINATION ASSESSMENT	4-1
4.1	PHASE II RESULTS	4-1
4.2	ACIDS AREA/YELLOW WATER RESERVOIR	4-2
	4.2.1 REVIEW OF PHASE I RI RESULTS	4-2
	4.2.2 PHASE II RESULTS	4-2
	4.2.3 TIME-SERIES SAMPLING RESULTS	4-9
4.3	RED WATER RESERVOIRS	4-19
	4.3.1 REVIEW OF PHASE I RI RESULTS	4-19
	4.3.2 PHASE II RESULTS	4-19
	4.3.2.1 Ground Water	4-19
	4.3.2.2 Sediments	4-26
4.4	POND 13/WET WELL AREA	4-29
	4.4.1 REVIEW OF PHASE I RI RESULTS	4-29
	4.4.2 PHASE II RESULTS	4-29

TABLE OF CONTENTS
(Continued, Page 3 of 3)

Section		Page
	5.0 SUMMARY AND CONCLUSIONS	5-1
5.1	ACIDS AREA/YELLOW WATER RESERVOIR	5-1
5.2	RED WATER RESERVOIRS	5-1
5.3	POND 13/WET WELL AREA	5-2
REFERENCES		
APPENDIXES		
	APPENDIX A--PHASE II WELL DEVELOPMENT DATA	
	APPENDIX B--PHASE II WELL LOGS	
	APPENDIX C--PHASE II CHEMICAL ANALYSES	
	APPENDIX D--PHASE II LAND SURVEY DATA	

LIST OF TABLES

Table		Page
1	Supplemental RI Field Program	ES-5
1.1-1	Summary of Contamination Status of the Second Operable Unit at WVOW	1-6
1.3-1	Supplemental RI Field Program	1-10
2.1-1	Monitor Well Site Selection Rationale, Phase II Field Program	2-6
2.3-1	Well Construction Materials	2-10
2.4-1	Phase II Ground Water Sampling Summary	2-16
2.4-2	Ground Water Sample Analysis Schedule	2-18
3.1-1	Comparison of Surface Water Station Elevations and Elevations of First Permeable Layer Encountered in Adjacent Monitor Wells	3-4
3.2-1	Monitor Well Construction--Phase I and Phase II	3-10
3.2-2	Ground Water Levels for Monitor Wells--Phase I and Phase II	3-12
3.2-3	Ground Water Levels for Observation Wells--Phase I and Phase II	3-14
3.2-4	Sediment Hydraulic Conductivity Properties	3-16
3.2-5	Physical Analysis of Aquifer Sediments	3-18
3.6-1	Surface Water Elevations--April 22, 1986	3-51
3.7-1	Gray Clay Confining Layer--Extent and Characteristics	3-54
4.2-1	Phase II Chemical Data for Ground Water in the Acids Area/Yellow Water Reservoir	4-4
4.2-2	Time-Series Sampling Water-Level Measurements--August 11-13, 1986	4-10

AR304531

LIST OF TABLES
(Continued, Page 2 of 2)

Table		Page
4.2-3	Chemical Results of Time-Series Sampling of Monitor Well GW27 (Shallow Aquifer)	4-12
4.2-4	Chemical Results of Time-Series Sampling of Monitor Well GW27D (Deep Aquifer)	4-13
4.3-1	Phase II Chemical Data for Ground Water in the Red Water Reservoirs, April 1986	4-21
4.3-2	Phase II Chemical Data for Ground Water in the Red Water Reservoirs, August 1986	4-25
4.3-3	Phase II Chemical Data for Sediments in the Red Water Reservoirs	4-27
4.4-1	Phase II Chemical Data for Ground Water in the Pond 13/Wet Well Area	4-31

LIST OF FIGURES

Figure		Page
1	WVOW Study Areas	ES-2
1.0-1	WVOW Study Areas	1-2
1.1-1	Overall Contamination Summary at WVOW	1-4
2.1-1	Phase II Sediment Sampling Locations in the Red Water Reservoirs	2-2
2.1-2	Locations of Water-Level Observation Wells	2-4
2.1-3	Locations of Monitor Wells, EPA Wells, and Offsite Domestic Wells	2-5
2.3-1	Phase II Observation Well Construction (OW32S)	2-9
2.3-2	Typical Monitor Well Construction	2-11
2.4-1	Locations of Wells Sampled During Phase II	2-14
3.2-1	Locations of Water-Level Observation Wells	3-7
3.2-2	Locations of Monitor Wells, EPA Wells, and Offsite Domestic Wells	3-8
3.2-3	Geologic Cross-Section Index Map	3-9
3.3-1	Geologic Cross-Section Locations in Acids Area/Yellow Water Reservoir	3-21
3.3-2	Geologic Cross-Section A-A', Acids Area/Yellow Water Reservoir	3-22
3.3-3	Geologic Cross-Section B-B', Acids Area/Yellow Water Reservoir	3-23
3.3-4	Water-Level Contours, Shallow Aquifer, Acids Area/Yellow Water Reservoir—April 22, 1986	3-25
3.3-5	Water-Level Contours, Shallow Aquifer, Acids Area/Yellow Water Reservoir—August 11, 1986	3-26
3.4-1	Geologic Cross-Section Locations in the Red Water Reservoirs Area	3-33
3.4-2	Geologic Cross-Section C-C', Red Water Reservoirs	3-34

AR304533

LIST OF FIGURES
(Continued, Page 2 of 3)

Figure		Page
3.4-3	Geologic Cross-Section D-D', Red Water Reservoirs	3-35
3.4-4	Water-Level Contours, Shallow Aquifer, Red Water Reservoirs--August 14, 1986	3-36
3.4-5	Water-Level Contours, Shallow Aquifer, Red Water Reservoirs—April 22, 1986	3-37
3.4-6	Water-Level Contours, Red Water Reservoirs--January 7, 1985	3-38
3.5-1	West-to-East Geologic Cross-Section in the Pond 13 Area	3-43
3.5-2	Locations of Ground Water Monitor and Observation Wells in Pond 13/Wet Well Area	3-45
3.5-3	Geologic Cross Section E-E', Pond 13/Wet Well Area	3-47
3.5-4	Ground Water Levels, Pond 13/Wet Well Area—April 22, 1986	3-48
3.6-1	Locations of Surface Water Gaging Stations	3-52
3.7-1	Thickness of Gray Clay Confining Layer	3-55
3.7-2	Elevation--Top of Gray Clay Confining Layer	3-56
3.7-3	Sitewide Ground Water Level Contours, Shallow Aquifer—April 22, 1986	3-57
3.7-4	Sitewide Potentiometric Contours, Deep Aquifer--April 22, 1986	3-58
4.2-1	Locations of Ground Water Monitor Wells in the Acids Area/Yellow Water Reservoir	4-3
4.2-2	Total Nitroaromatic Concentrations in the Ground Water—Acids Area/Yellow Water Reservoir, April 1986	4-5
4.2-3	Results of Time-Series Sampling of Monitor Wells GW27 and GW27D--Yellow Water Reservoir	4-14
4.3-1	Locations of Ground Water Monitor Wells in the Red Water Reservoirs, April 1986	4-20

AR304534

LIST OF FIGURES
(Continued, Page 3 of 3)

Figure		Page
4.3-2	Total Nitroaromatic Concentrations in the Ground Water in the Red Water Reservoirs, April 1986	4-22
4.4-1	Locations of Ground Water Monitor Wells in the Pond 13/Wet Well Area	4-30
4.4-2	Concentrations of Total Nitroaromatic Compounds in Monitor Wells and EPA Wells in the Pond 13/ Wet Well Area	4-32

LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
$CaCO_3$	calcium carbonate
CE	U.S. Army Corps of Engineers
cm/sec	centimeters per second
1,3-DNB	1,3-dinitrobenzene
2,4-DNT	2,4-dinitrotoluene
2,6-DNT	2,6-dinitrotoluene
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
FS	Feasibility Study
ft	foot
ft/day	feet per day
ft/ft	feet per foot
ft-MSL	feet above mean sea level
ft/sec	feet per second
ft^2	square feet
ft^3	cubic feet
gal	gallons
gpm	gallons per minute
ID	inside diameter
McClintic Wildlife Station	Clifton F. McClintic State Wildlife Station
mg/L	milligrams per liter
mm	millimeters
N	nitrogen
NA	not analyzed
NIPDWR	National Interim Primary Drinking Water Regulations
OD	outside diameter
PAH	polynuclear aromatic hydrocarbons
PVC	polyvinyl chloride

QA	Quality Assurance
QC	Quality Control
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SR	State Route
TNB	trinitrobenzene
1,3,5-TNB	1,3,5-trinitrobenzene
2,4,6-TNT	2,4,6-trinitrotoluene
μg/g	micrograms per gram
μg/L	micrograms per liter
μmho/cm	micromhos per centimeter
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
VC	vertical composite sample
WVOW	West Virginia Ordnance Works

EXECUTIVE SUMMARY

PURPOSE OF THE SUPPLEMENTAL REMEDIAL INVESTIGATION

The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) issued Contract No. DAAK11-83-D-0007 to Environmental Science and Engineering, Inc. (ESE) to perform tasks relating to the Multi-Installation Eastern Sites Environmental Contamination Surveys Program. Task Number 0004, Delivery Order Number 0005, comprises a Remedial Investigation/ Feasibility Study (RI/FS) of the former West Virginia Ordnance Works (WVOW) to assess contamination and contamination migration in the soils, surface water, and ground water as a result of past 2,4,6-trinitrotoluene (2,4,6-TNT) manufacturing operations and to evaluate potential remedial action alternatives. The layout of the former industrial facility is shown in Fig. 1.

The Remedial Investigation (RI) report (ESE, 1986d) detailed the sitewide contamination status of WVOW. For certain areas of concern (specifically the Acids Area/Yellow Water Reservoir, the Red Water Reservoirs, and the Pond 13/Wet Well Area), important uncertainties remained regarding the source, extent, and migration potential of contaminated ground water. These uncertainties dictated that additional field data be collected to support remedial alternative decisionmaking.

To expedite implementation of source area remedial actions, WVOW was divided into two operable units. The first operable unit included the TNT Manufacturing Area, the Burning Grounds Area, and the industrial sewerlines. The second operable unit included the Acids Area/Yellow Water Reservoir, the Red Water Reservoirs area, and the Pond 13/Wet Well Area. The available data for the first operable unit were sufficient to complete the RI/FS process; all studies have been completed, and the Record of Decision (ROD) for the first operable unit is scheduled to be signed in April 1987.

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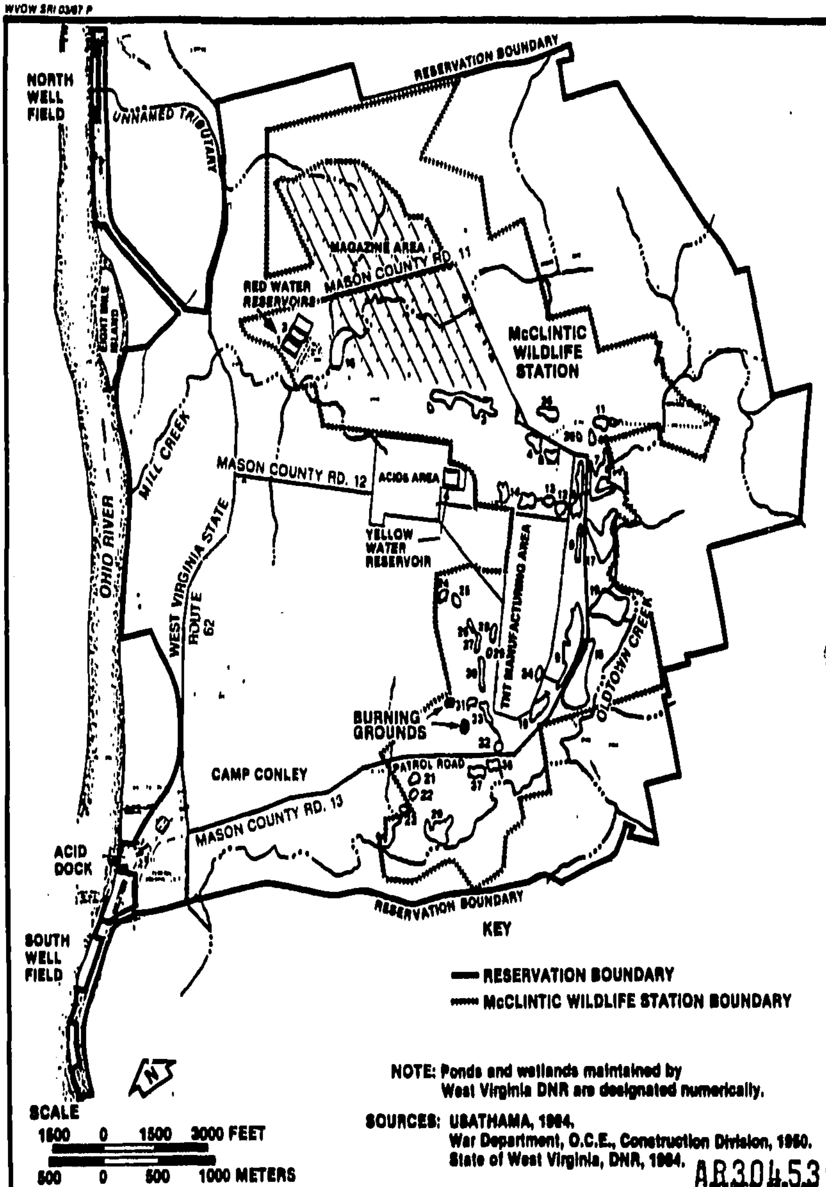

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Figure 1 WVOW STUDY AREAS	WEST VIRGINIA ORDNANCE WORKS Supplemental Remedial Investigation Phase II Field Program

This report presents the findings of the supplemental RI survey and summarizes the Phase II field program (March through August 1986) conducted at WVOW in each area of concern in the second operable unit.

SUPPLEMENTAL RI OBJECTIVES

The objectives of the supplemental RI by area were:

1. Acids Area/Yellow Water Reservoir
   a. Determine the limit of contamination in the shallow alluvial aquifer.
   b. Verify the presence and thickness of the gray clay confining layer and assess the potential for downward vertical contaminant migration.
2. Red Water Reservoirs
   a. Refine estimate of contaminant source strength in the reservoir sediments.
   b. Determine the limit of contamination in the shallow alluvial aquifer.
   c. Verify the presence and thickness of the gray clay confining layer and assess the potential for downward vertical contaminant migration.
3. Pond 13/Wet Well Area
   a. Assess ground water flow direction in the shallow aquifer.
   b. Determine the limit of contamination in the shallow alluvial aquifer.
   c. Verify the presence and thickness of the gray clay confining layer and assess the potential for downward vertical contaminant migration.

SUPPLEMENTAL RI APPROACH AND SCOPE

The Phase II Supplemental RI included shallow and deep monitor well installation, water-level observation well installation, sediment sampling, water-level measurements, and ground water sampling.

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addition to sampling the wells installed in the supplemental RI program, existing monitor wells were sampled in each of the three areas of concern to relate the data from the new wells to the existing data base.

The supplemental RI field program was initiated in March 1986. Ground water samples from three new deep monitor wells contained detectable nitroaromatics. The relative concentration of nitroaromatics in the deep wells compared with adjacent shallow contaminated wells indicated the probability that contaminated ground water from the shallow aquifer was carried into the deep aquifer during drilling.

To determine the source of the low levels of nitroaromatics observed in the deep monitor wells, a deep well resampling program was conducted in August 1986. One of the three wells was selected for time-series sampling. In the time-series sampling, the well was pumped continuously for an extended period of time and was sampled at periodic time steps throughout the pumping. Each successive pumped sample represented ground water quality at increasing distance from the pumped well. The pattern of contaminant arrival, concentration, and duration provided data relevant to the presence, strength, and location of the contaminant source. Selected deep and shallow monitor wells also were resampled.

The individual elements of the supplemental RI field program are presented in Table 1.

SUPPLEMENTAL RI RESULTS

The principal findings of the supplemental RI area of concern within the second operable unit are described in the following sections.

ACIDS AREA/YELLOW WATER RESERVOIR

1. Contaminant sources were identified in the Phase I survey and include the sediments of the Yellow Water Reservoir and contaminated soil in the vicinity of the neutralization chamber.
2. Nitroaromatic contamination exists in the shallow aquifer. The contamination is limited in areal extent.

Table 1. Supplemental RI Field Program

Area of Concern	Field Program Elements
Acids Area/Yellow Water Reservoir	1. Install one shallow monitor well. 2. Install one deep monitor well. 3. Sample new and existing wells. 4. Conduct time-series sampling of deep monitor well.
Red Water Reservoirs	1. Install three shallow monitor wells. 2. Install one deep monitor well. 3. Conduct sediment sampling of reservoirs. 4. Sample new and existing wells.
Pond 13/Wet Well Area	1. Install one shallow monitor well. 2. Install one deep monitor well. 3. Install one shallow water-level observation well. 4. Sample new and existing wells.
Other Tasks	1. Measure water levels at all wells and surface water gaging stations at WVOW (April 1986). 2. Resample Well GW36D (TNT Manufacturing Area). 3. Install shallow monitor well at north portion of TNT Manufacturing Area. 4. Sample deep water supply well at Clifton F. McClintic State Wildlife Station (McClintic Wildlife Station).

Source: ESE, 1987.

3. The gray clay confining layer is present at the Yellow Water Reservoir and acts as an effective barrier to vertical contaminant migration.
4. The contamination detected in the deep aquifer in April 1986 was attributed to shallow contamination being carried into the deep aquifer during drilling. The data obtained during the time-series sampling of GW27D and the resampling of GW36D confirmed this theory.
5. Ground water flow direction in the shallow aquifer is to the west; ground water flow in the deep aquifer is to the north.

RED WATER RESERVOIRS

1. The source strength of the sediments of Pond 1 and Pond 2 was refined through the sampling and analysis of deep sediment cores. Low levels of nitroaromatics were detected in several of the deeper sediment samples.
2. Nitroaromatic contamination was detected in the shallow ground water at Monitor Wells GW30, GW45, GW46, GW47, and SHW6. At SHW6, located at State Route (SR) 62, the contamination is present at very low levels [0.2 micrograms per liter (μg/L) of 2,4,6-TNT]; the downgradient limit of contamination is projected to occur at or immediately west of SR 62.
3. The gray clay confining layer is present at the Red Water Reservoirs and acts as an effective barrier to vertical contaminant migration.
4. The apparent low-level contamination detected in the deep aquifer in 1986 is attributed to shallow contamination being carried into the deep aquifer during drilling. The data obtained during the time-series sampling of GW27D and the resampling of GW36D confirm this theory.
5. Ground water flow direction in the shallow aquifer is to the northwest; ground water flow in the deep aquifer is expected to have a northerly component.

POND 13/WET WELL AREA

1. A major source of the contamination observed at Pond 13 is the nearby Wet Well W1.
2. The shallow sand aquifer appears to be areally limited and is bounded by clay-dominant sediments observed at GW48D to the north and GW22D to the east.
3. The gray clay confining layer is present at Pond 13 and acts as an effective barrier to vertical migration.
4. Based on the water levels measured in the RI (ESE, 1986d) and supplemental RI (ESE, 1986a), essentially no direction of ground water flow is apparent in the shallow aquifer.
5. The hydraulic head observed in the deep monitor wells is higher than those observed in the shallow aquifer, further substantiating the conclusion that vertical contaminant migration at Pond 13 is unlikely.

1.0 INTRODUCTION

The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) issued Contract No. DAAK11-83-D-0007 to Environmental Science and Engineering, Inc. (ESE) to perform tasks relating to the Multi-Installation Eastern Sites Environmental Contamination Surveys Program. Task Number 0004, Delivery Order Number 0005, comprises a Remedial Investigation/ Feasibility Study (RI/FS) of the former West Virginia Ordnance Works (WVOW) to assess contamination and contamination migration in the soils, surface water, and ground water as a result of past 2,4,6-trinitrotoluene (2,4,6-TNT) manufacturing operations and to evaluate potential remedial action alternatives. The layout of the former industrial facility is shown in Fig. 1.0-1.

The Remedial Investigation (RI) report (ESE, 1986d) detailed the sitewide contamination status of WVOW. For certain areas of concern (specifically the Acids Area/Yellow Water Reservoir, the Red Water Reservoirs, and the Pond 13/Wet Well Area), important uncertainties remained regarding the source, extent, and migration potential of contaminated ground water. These uncertainties dictated that additional field data be collected to support remedial alternative decisionmaking.

To expedite implementation of source area remedial actions, WVOW was divided into two operable units. The first operable unit included the TNT Manufacturing Area, the Burning Grounds Area, and the industrial sewerlines. The second operable unit included the Acids Area/Yellow Water Reservoir, the Red Water Reservoirs area, and the Pond 13/Wet Well Area. The available data for the first operable unit were sufficient to complete the RI/FS process; all studies have been completed and the Record of Decision (ROD) for the first operable unit is scheduled to be signed in April 1987.

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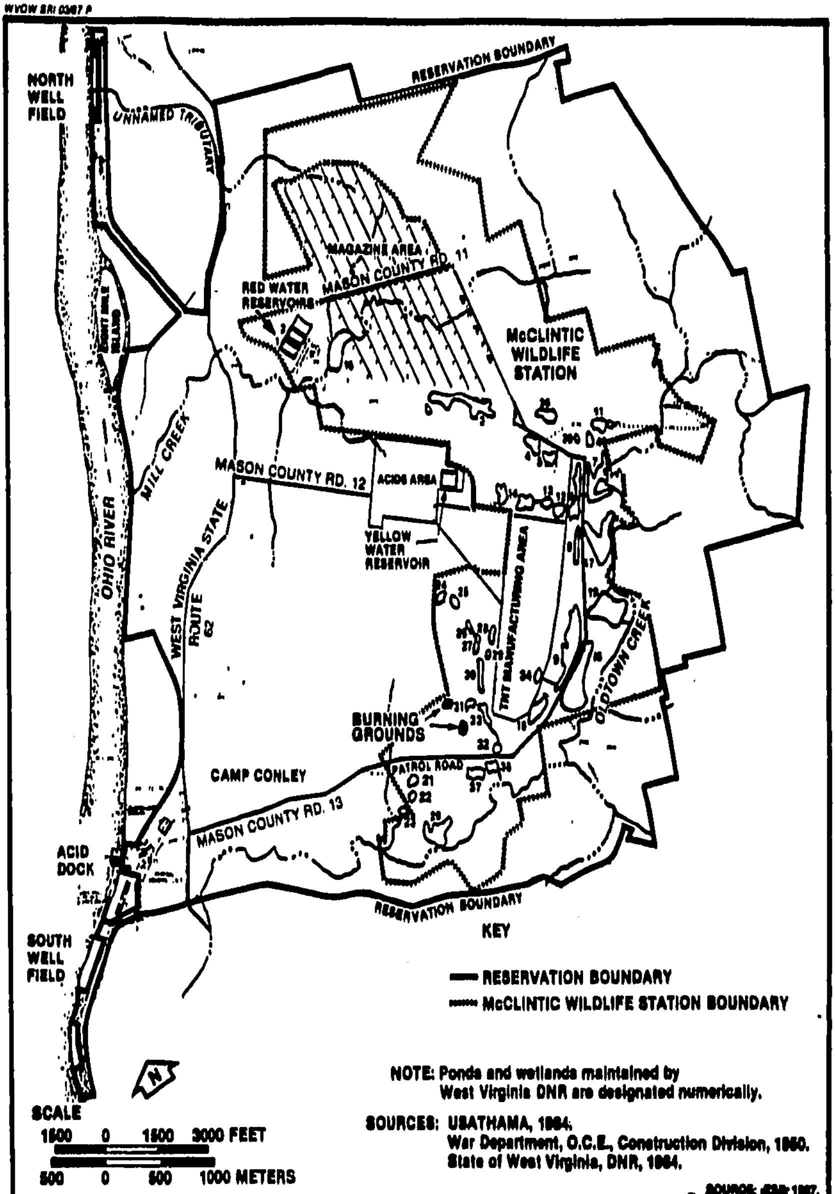

Figure 1.0-1
WVOW STUDY AREAS

WEST VIRGINIA ORDNANCE WORKS
Supplemental Remedial Investigation
Phase II Field Program

This report presents the findings of the supplemental RI survey and summarizes the Phase II field program (March through August 1986) conducted at WVOW in each area of concern in the second operable unit.

1.1 SUMMARY OF CONTAMINATION STATUS

The following paragraphs are a summary of the overall site contaminant sources and contaminated media. The principal sitewide contaminants are nitroaromatic residues, and the predominant compound observed was 2,4,6-TNT; 1,3,5-trinitrobenzene (1,3,5-TNB) and 2,4-dinitrotoluene (2,4-DNT) were also widely distributed. The major nitroaromatic contaminant source areas are shown in Fig. 1.1-1 and include:

1. The surface and subsurface soils in the TNT Manufacturing Area,
2. The industrial sewerlines in the TNT Manufacturing Area and the trunk sewerlines leading from the Pond 13 area to the outfalls, and
3. The surface soils in the East and West Burning Grounds.

In these areas, concentrations ranging to the low-percent levels (<10 percent) were encountered. Fist-sized pieces of crystalline nitroaromatic residue were encountered in the Burning Grounds Area. These source areas contribute surface water and ground water contamination by nitroaromatics and represent a hazard to human beings and wildlife as a result of direct contact. A very small area [approximately 100 square feet (ft^2)] of surface soils in the Acids Area/Yellow Water Reservoir area is also contaminated with nitroaromatics to approximately the 1-percent level.

The Red Water Reservoirs sediments, Yellow Water Reservoir soils, and the Wet Well/Pond 13 seep area sediments are contaminated to a lesser degree and do not represent a direct contact threat, but contribute to surface water and ground water contamination. These source areas are shown in Fig. 1.1-1.

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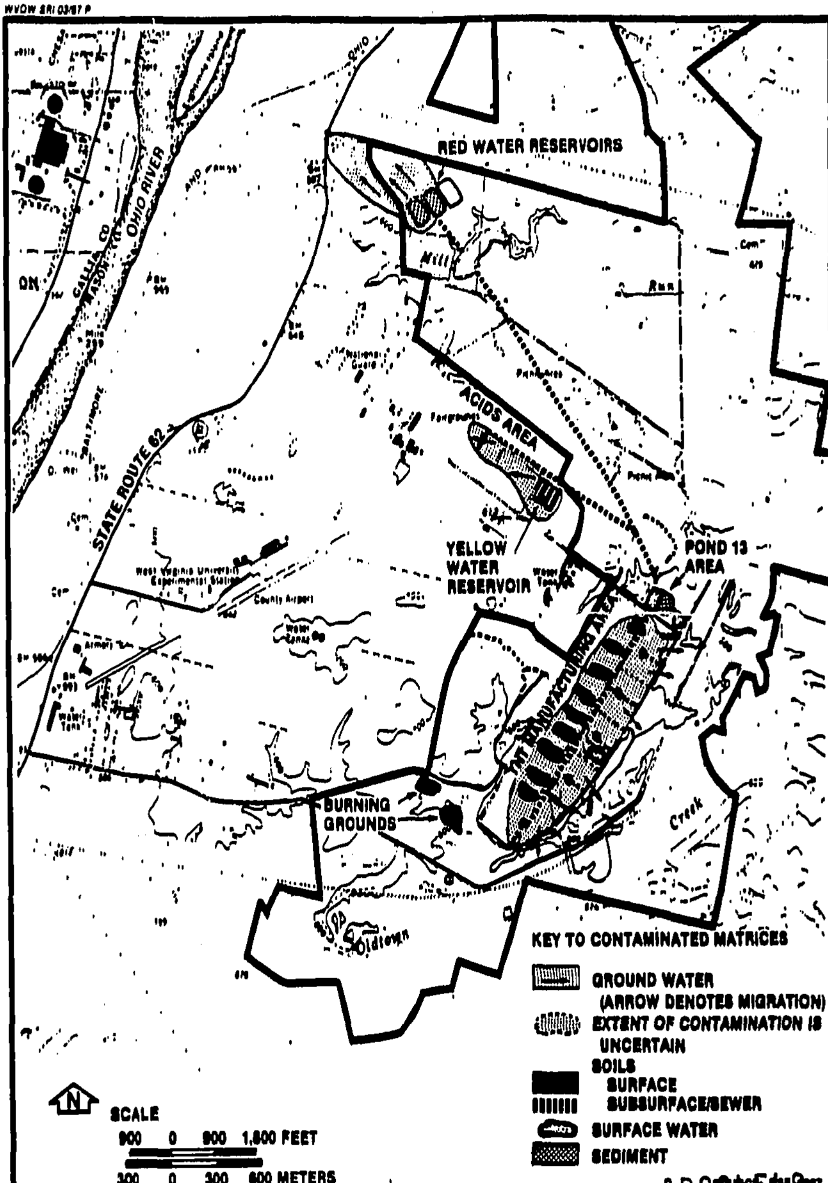

Figure 1.1-1
OVERALL CONTAMINATION SUMMARY
AT WVOW

WEST VIRGINIA
ORDNANCE WORKS
Supplemental Remedial Investigation
Phase II Field Program

Asbestos, disposed primarily at the West Burning Grounds, represents a direct contact hazard in this area. Surface water migration of asbestos is occurring into the drainage leading from this source area into Oldtown Creek. Waters of the drainage area and Oldtown Creek are not used as drinking water sources or for body contact recreation. Polynuclear aromatic hydrocarbons (PAHs) and lead also were observed in the West Burning Grounds. Although these contaminants represent a potential contact hazard in the source area, no generalized migration appears to have occurred. Asbestos also exists offsite in the powerhouses and Mason Furniture Co. Access to the south powerhouse is not restricted. Mason Furniture Co. is privately owned.

Table 1.1-1 indicates the maximum concentrations observed in various contaminated areas and media for categories of contaminants associated with the WVOW site. In each area, sampling strategy was designed to identify and sample the most contaminated areas, so the maximum concentrations are not necessarily representative of the typical concentration in each source area. In virtually all source areas, several samples were collected that were uncontaminated, thus realistically defining the extent of contamination. Details of the contaminant distribution in each source area are presented in the RI report (ESE, 1986d).

1.2 SUPPLEMENTAL RI OBJECTIVES

As stated previously, important uncertainties remained at the conclusion of the initial RI survey regarding the source, extent, and migration potential of contaminated ground water for the areas of concern within the second operable unit. Specific objectives were determined for each area of concern. The objectives of the supplemental RI by area are:

1. Acids Area/Yellow Water Reservoir
   a. Determine the limit of contamination in the shallow ground-water aquifer.
   b. Verify the presence and thickness of the gray clay confining layer and assess the potential for downward vertical contaminant migration.

AR304549

Table 1.1-1. Summary of Contamination Status of the Second Operable Unit at WVOW

Environmental Medium	Contaminant	Maximum Concentration Detected*
Acids Area/Yellow Water Reservoir		
Soils	Nitroaromatics	1% (isolated area approximately 100 ft^2)
	Lead	100 µg/g
Sewerlines	Nitroaromatics	2,830 µg/g
Surface Water	Uncontaminated	—
Ground Water	Nitroaromatics	15 µg/L
Red Water Reservoirs		
Soils	Uncontaminated	—
Sewerlines	Nitroaromatics	0.2%
Surface Water	Uncontaminated	—
Sediments	Nitroaromatics	2,210 µg/g
Ground Water	Nitroaromatics	17 µg/L
Pond 13/Wet Well Area		
Soils	Nitroaromatics	5.5 µg/g
Sewerlines	Uncontaminated	—
Surface Water	Nitroaromatics	70 µg/L
	Lead	32 µg/L†

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Table 1.1-1. Summary of Contamination Status of the Second Operable Unit at WVOW (Continued, Page 2 of 2)

Environmental Medium	Contaminant	Maximum Concentration Detected*
Pond 13/Wet Well Area (Continued)		
Sediments	Nitroaromatics	4,240 µg/g
Ground Water	Nitroaromatics	50,000 µg/L

Note: µg/g = micrograms per gram.
µg/L = micrograms per liter.

*In each area, sampling strategy was designed to identify and sample the most contaminated areas, so the maximum concentrations are not necessarily representative of the typical concentration in each source area. In virtually all source areas, several samples were collected that were uncontaminated, thus realistically defining the extent of contamination.

†Lead in ground and surface waters did not exceed relevant standards or criteria [e.g., National Interim Primary Drinking Water Regulations (NIPDWR) = 50 µg/L].

Source: ESE, 1987.

2. Red Water Reservoirs
   a. Refine estimate of contaminant source strength in the reservoir sediments.
   b. Determine the limit of contamination in the shallow alluvial aquifer.
   c. Verify the presence and thickness of the gray clay confining layer and assess the potential for downward vertical contaminant migration.
3. Pond 13/Wet Well Area
   a. Assess ground water flow direction in the shallow aquifer.
   b. Determine the limit of contamination in the shallow alluvial aquifer.
   c. Verify the presence and thickness of the gray clay confining layer and assess the potential for downward vertical contaminant migration.

1.3 SUPPLEMENTAL RI APPROACH AND SCOPE

To address the data gaps listed in Sec. 1.1, the Phase II Supplemental RI included shallow and deep monitor well installation, water-level observation well installation, sediment sampling, water-level measurements, and ground water sampling. In addition to sampling the wells installed in the supplemental RI program, existing monitor wells were sampled in each of the three areas of concern to relate the chemical data from the new wells to the existing data base.

The supplemental RI field program was initiated in March 1986. Ground water samples from three new deep monitor wells contained detectable nitroaromatics. The relative concentration of nitroaromatics in the deep wells compared with adjacent shallow contaminated wells indicated the probability that contaminated ground water from the shallow aquifer was carried into the deep aquifer during drilling.

To determine the source of the low levels of nitroaromatics observed in the deep monitor wells, a deep well resampling program was conducted in August 1986. One of the three wells was selected for time-series sampling. In the time-series sampling, the well (GW27D) was pumped continuously for an extended period of time and was sampled at periodic time steps throughout the pumping. Each successive pumped sample represents ground water quality at increasing distance from the pumped well. The pattern of contaminant arrival, concentration, and duration provided data relevant to the presence, strength, and location of the contaminant source. Selected deep and shallow monitor wells also were resampled.

The individual elements of the supplemental RI field program are presented in Table 1.3-1.

1.4 SUPPLEMENTAL RI REPORT ORGANIZATION

This supplemental RI report is structured in general accordance with format guidance from the U.S. Environmental Protection Agency (EPA) (EPA, 1985). The overall format of data presentation is grouped by major area of concern.

Sec. 1.0 (Introduction) presents an overview of previous studies conducted at the site, a summary of the supplemental RI survey, and the structure of the RI report.

Sec. 2.0 (Field Methodology) describes the technical activities and investigations performed during the supplemental RI survey. This section also includes the site selection rationale for sediment sampling and monitor well installation. The specific field and analytical procedures (e.g., monitor well drilling, borehole logs, chemical analyses) employed in the supplemental RI survey followed those procedures employed in the initial RI survey. As such, these detailed procedures are incorporated by reference (ESE, 1986d) and are not presented in detail in this report.

Table 1.3-1. Supplemental RI Field Program

Area of Concern	Field Program Elements
Acids Area/Yellow Water Reservoir	1. Install one shallow monitor well. 2. Install one deep monitor well. 3. Sample new and existing wells. 4. Conduct time-series sampling of deep monitor well.
Red Water Reservoirs	1. Install three shallow monitor wells. 2. Install one deep monitor well. 3. Conduct sediment sampling of reservoirs. 4. Sample new and existing wells.
Pond 13/Wet Well Area	1. Install one shallow monitor well. 2. Install one deep monitor well. 3. Install one shallow water-level observation well. 4. Sample new and existing wells.
Other Tasks	1. Measure water levels at all wells and surface water gaging stations at WVOW (April 1986). 2. Resample Well GW36D (TNT Manufacturing Area). 3. Install shallow monitor well at north portion of TNT Manufacturing Area. 4. Sample deep aquifer water supply well at Clifton F. McClintic Wildlife Station (McClintic Wildlife Station).

Source: ESE, 1987.

Sec. 3.0 (Ground Water Hydrology) presents the results of the supplemental hydrogeologic investigation for each area of concern. A discussion of sitewide hydrogeology as it affects nitroaromatic contaminant distribution and migration potential is also included.

Sec. 4.0 (Contamination Assessment) presents the results of the supplemental sampling and analysis program for each area of concern.

Sec. 5.0 (Summary and Conclusions) presents the significant results of the supplemental RI survey for each area of concern.

2.0 SUPPLEMENTAL RI FIELD PROGRAM METHODOLOGY

The supplemental RI field and laboratory programs were carried out from March through September 1986 to refine the nature and extent of ground water contamination to meet the objectives described in Sec. 1.2. The protocols and methodologies for the field and laboratory programs were the same as those used in the initial RI program; these procedures are described in the following appendixes of the initial RI report (ESE, 1986d):

- App. A--Geotechnical Investigation Methodology (well drilling and installation, ground water sampling, water-level measurements)
- App. B--Surface Water and Sediment Investigation Methodology (sediment sampling)
- App. D--Laboratory Procedures and Data Reduction (chemical analysis, sample control, data management)
- App. E--Quality Assurance [Project Quality Assurance (QA) Plan]

These appendixes of the initial RI report are not reproduced herein.

The supplemental RI program included water-level observation well installation, monitor well installation, water-level measurements, sediment sampling, monitor well sampling, and laboratory analyses of water and sediment samples.

2.1 <u>SITE SELECTION RATIONALE</u>

2.1.1 SEDIMENT SAMPLING LOCATIONS

Additional sediment samples were collected during the supplemental RI program in order to refine the contaminant source strength in the sediments of Ponds 1 and 2, the Red Water Reservoirs. At Pond 1, samples were collected at the north end, at the center, and at the former outlet flow structure. At Pond 2, sampling stations were located at the north end, at the center, and at the former inlet structure. The RI sampling locations are shown in Fig. 2.1-1.

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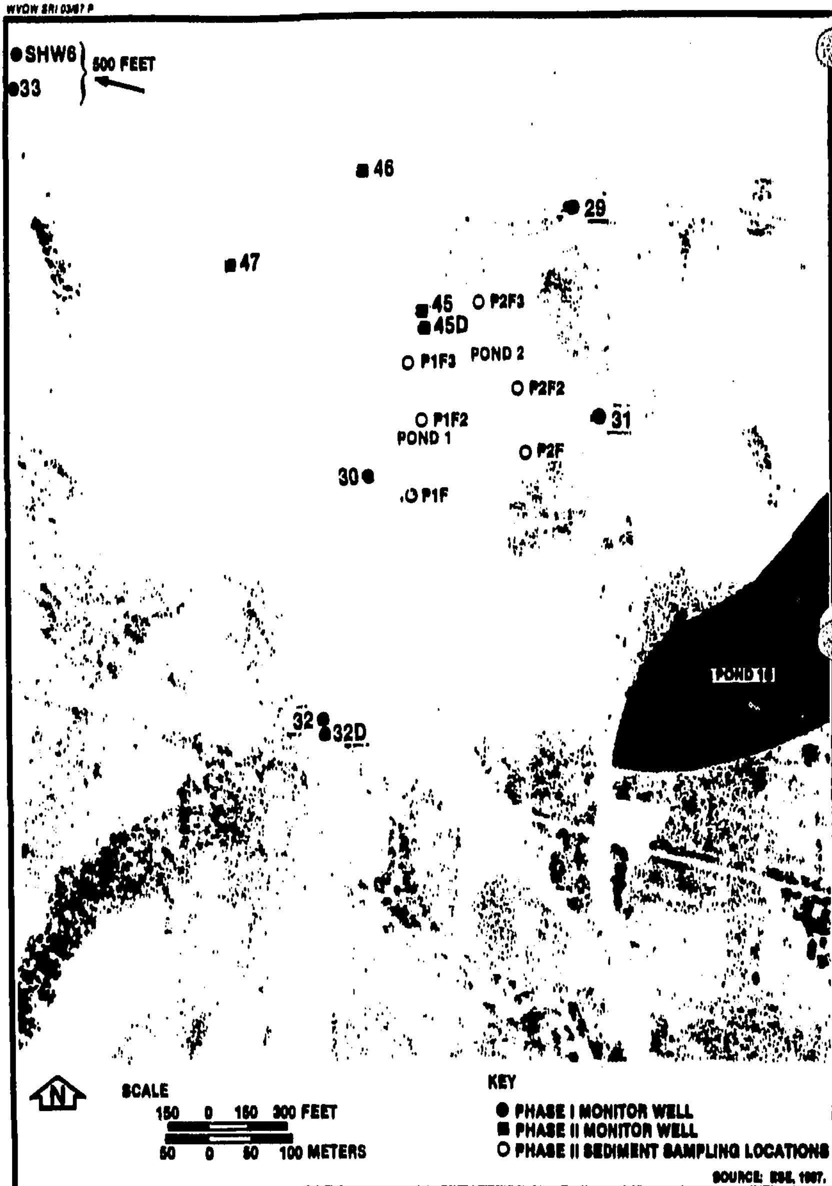

Figure 2.1-1
PHASE II SEDIMENT SAMPLING LOCATIONS
IN THE RED WATER RESERVOIRS

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Supplemental Remedial Investigation
Phase II Field Program

557

2.1.2 WATER-LEVEL OBSERVATION WELL LOCATION

One additional water-level observation well (OW32S) was installed at the Pond 13/Wet Well Area during the supplemental RI program. The well, which is located west of Wet Well No. 1 and northwest of Well EPA04, is completed in the shallow aquifer. The well location was selected to provide additional areal coverage to aid in the definition of shallow ground water flow patterns. The observation well location is shown in Fig. 2.1-2.

2.1.3 MONITOR WELL LOCATIONS

Nine monitor wells were installed during the supplemental field RI program. The locations of all WVOW monitor wells are shown on Fig. 2.1-3. The site selection rationale for each Phase II monitor well is shown in Table 2.1-1.

2.2 WATER-LEVEL MEASUREMENTS

Water-level measurements were taken periodically throughout the field program. One complete set of water levels for all surface water and ground water stations was collected on Apr. 22, 1986; partial sets of ground water level measurements were collected on Aug. 11, 1986, and Aug. 14, 1986. Water levels were measured using either the wetted-tape method or an electric probe.

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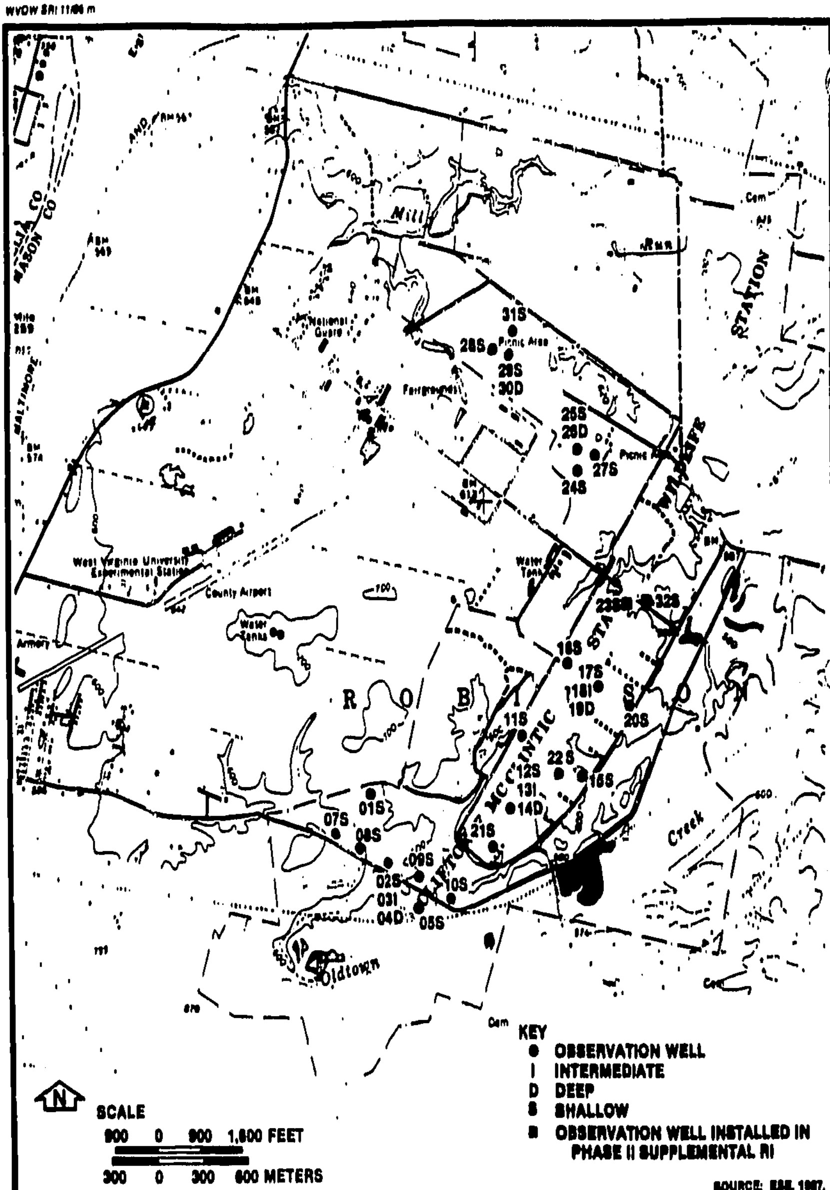

Figure 2.1-2
LOCATIONS OF WATER-LEVEL OBSERVATION WELLS

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Phase II Field Program

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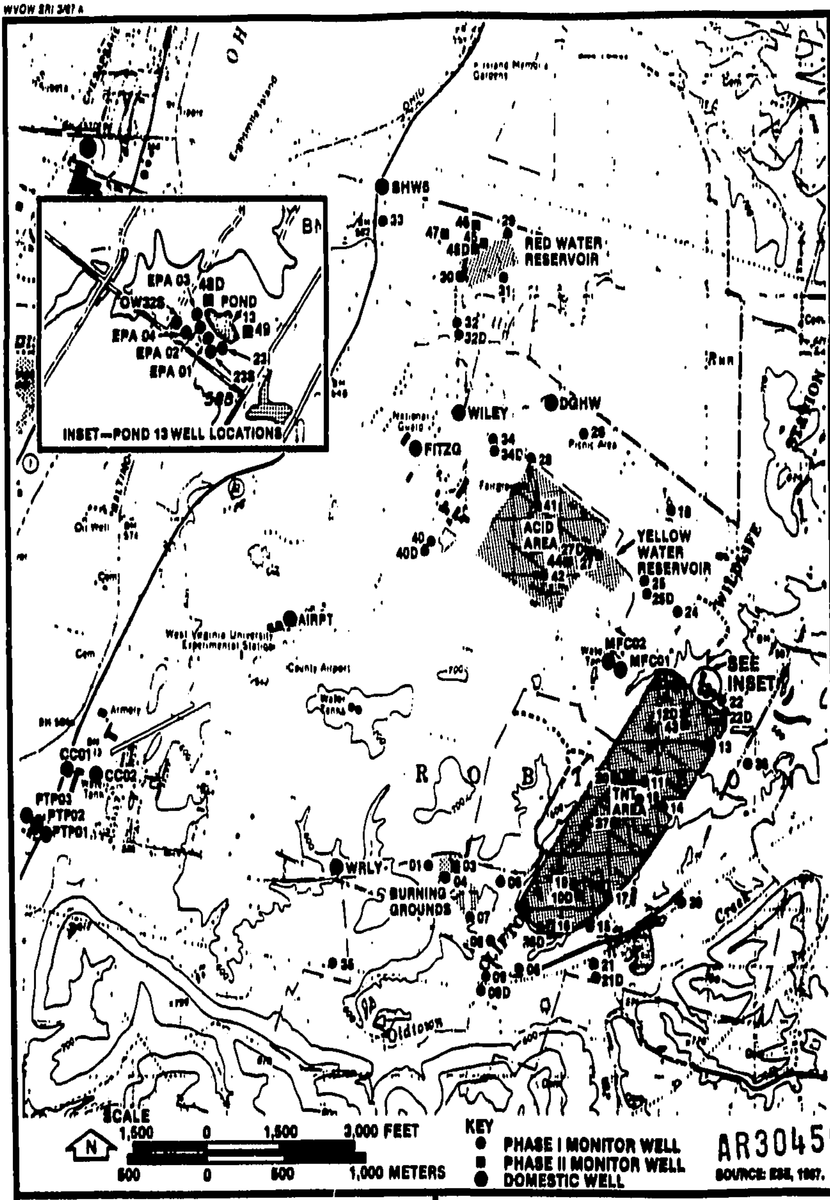

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Figure 2.1-3
LOCATIONS OF MONITOR WELLS, EPA WELLS, AND OFFSITE DOMESTIC WELLS

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Phase II Field Program

Table 2.1-1. Monitor Well Site Selection Rationale, Phase II Field Program

Well Designation	Selection Rationale
Yellow Water Reservoir	
GW27D	Located adjacent to Yellow Water Reservoir near Well GW27; verify presence and thickness of gray clay layer; assess water quality in deep aquifer; determine vertical hydraulic gradient.
GW44	Shallow well downgradient of Yellow Water Reservoir; define downgradient limit of contamination in shallow aquifer.
Red Water Reservoirs	
GW45, GW45D	Well pair immediately downgradient of Red Water Reservoirs; verify presence and thickness of gray clay layer; assess water quality in shallow and deep aquifers; determine vertical hydraulic gradient.
GW46, GW47	Shallow downgradient wells; provide better definition of ground water flow rate and direction.
Pond 13/Wet Well Area	
OW32S	Shallow water-level observation well northwest of EPA04. Provide additional definition of shallow aquifer extent and ground water movement.
GW43 (TNT Manufacturing Area)	Shallow well installed adjacent to GW12D. Determine shallow aquifer water quality in northern TNT Manufacturing Area near Pond 13; establish vertical hydraulic gradient.

Table 2.1-1. Monitor Well Site Selection Rationale, Phase II Field Program (Continued, Page 2 of 2)

Well Designation	Selection Rationale
GW48D	Assess ground water quality in deep aquifer; verify presence and thickness of gray clay layer; determine hydraulic head in deep aquifer. Originally intended as a well pair, the proposed shallow Well GW48 was not drilled when GW48D encountered only the deep aquifer. At GW48D, clay deposits extended from the surface to 75-foot (ft) depth; the shallow alluvial aquifer was not present.
GW49	Shallow aquifer monitor well east of Pond 13; provide better definition of ground water flow rate and direction.

Source: ESE, 1987.

2.3 WELL INSTALLATION

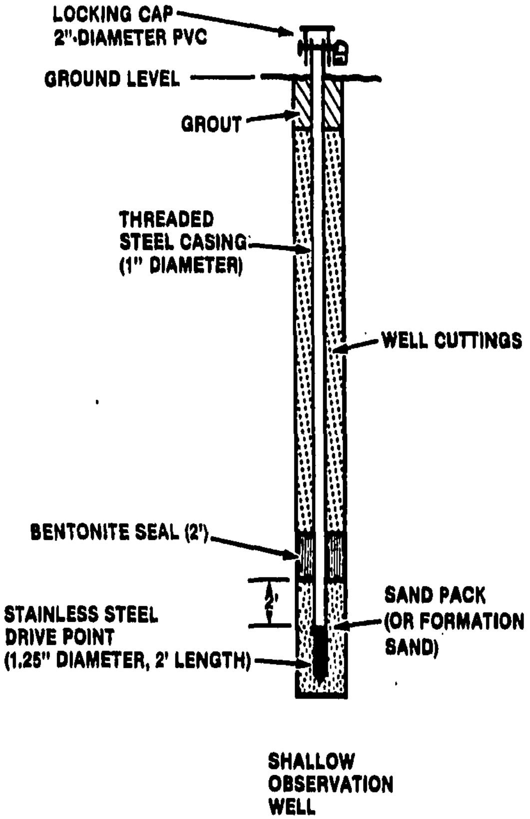
2.3.1 WATER-LEVEL OBSERVATION WELL

A single water-level observation well (OW32S) was installed at the Pond 13/Wet Well Area. The borehole was advanced by hand using a stainless-steel bucket auger. Borehole logging and documentation procedures and construction of the shallow observation well followed the detailed methodology contained in the initial RI report, App. A, Sec. A.2 (ESE, 1986d). Observation well construction is shown in Fig. 2.3-1.

2.3.2 GROUND WATER MONITOR WELLS

All monitor wells were constructed in accordance with the Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports (USATHAMA, 1983). Drilling was performed under contract to Bowser-Morner Testing, Inc., Dayton, OH. All wells were drilled by Patterson Well Drilling (a subcontractor to Bowser-Morner), Dayton, OH, using a Bucyrus-Erie 22W cable-tool drilling rig. Drilling procedures, borehole logging and documentation, well construction, and well development specifications followed the detailed methodology contained in App. A, Sec. A.2 of the initial RI report (ESE, 1986d). A summary table listing materials used in well construction is shown in Table 2.3-1. Typical well construction is shown in Fig. 2.3-2. Well construction specifications for all WVOW monitor wells are shown in Table 2.3-1. Summary data from the monitor well development program are included in App. A. Well logs are included in App. B.

Joseph L. Leach, a land surveyor registered in the State of West Virginia (Registration No. 183), surveyed all ground water sampling stations associated with this sampling and analysis program. In addition, existing monitor well EPA02 was resurveyed for elevation. U.S. Army Corps of Engineers (CE) benchmarks GA-47 and GA-53 were used as the reference markers for horizontal control at WVOW. Vertical control was obtained from U.S. Coast and Geodetic Survey markers Q104 and R104 along State Route (SR) 62. Location and description of all temporary



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SOURCE: ESE, 1997.

Figure 2.3-1
PHASE II OBSERVATION WELL
CONSTRUCTION (OW32S)

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Supplemental Remedial Investigation
Phase II Field Program

Table 2.3-1. Well Construction Materials

Material	Description/Brand	Source/Supplier
PVC Casing (Monitor Wells)	4.5-inch OD, Schedule 40, flush threaded	Diedrich Drilling Equipment, Inc., LaPorte, IN
PVC Screen (Monitor Wells)	4.5-inch OD, Schedule 40, flush threaded, 0.020-inch slot	Diedrich Drilling Equipment, Inc., LaPorte, IN
Stainless Steel Screen (Observation Well)	1.25-inch ID, Johnson Redhead®, stainless-steel drive point, wire wound, 0.010-inch slot	Johnson UOP, Inc., St. Paul, MN
Steel Casing (Observation Well)	1.0-inch ID, external couplings	Bowser-Morner Testing, Inc., Dayton, OH (locally obtained)
Bentonite (Powder)	Quik-gel© (western sodium bentonite)	NL Baroid, Houston, TX
Bentonite (Pellets)	Volclay® tablets (0.5-inch diameter)	American Colloid Company, Skokie, IL
Sand Pack	Best Sand, Grade 430	Best Sand Corporation, Chardon, OH
Cement	Portland® Type I, Lone Star Cement	Louisville Cement Co., Louisville, KY
Drilling Water	Glacial outwash (probable--no well log available)	"Doghouse" Well, located adjacent to a barracks-type building, 3,600 ft northwest of Ranger Station

Note: PVC = polyvinyl chloride.
OD = outside diameter.
ID = inside diameter.

Source: ESE, 1986a.

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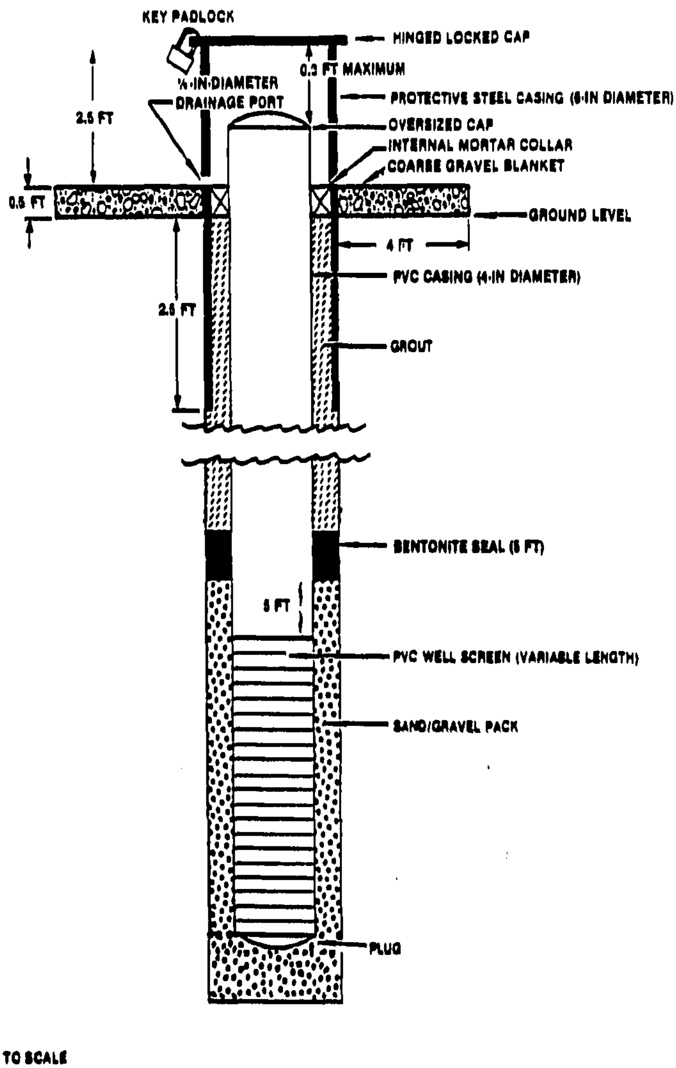

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Figure 2.3-2
TYPICAL MONITOR WELL CONSTRUCTION

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Phase II Field Program

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benchmarks are included in the surveyor's field notes. All surveying data were recorded in state planar coordinates. All survey calculations, map location and description of permanent benchmarks, and documentation of survey closure accuracy are contained in the surveyor's report (App. D).

2.4 GROUND WATER SAMPLE COLLECTION PROGRAM

The ground water sampling program consisted of sampling all new monitor wells and selected existing monitor wells in April 1986. An additional sampling program which focused on the deep monitor wells was conducted in August 1986. The locations of the wells sampled during Phase II are shown in Fig. 2.4-1. The August program included time-series sampling of GW27D and GW27 and routine sampling of additional shallow and deep monitor wells. With the exception of the time-series sampling, single-well sampling followed the procedures described in App. A, Sec. A.5 of the initial RI report (ESE, 1986d).

The time-series sampling program was initiated when low levels of nitroaromatics were detected in deep Monitor Wells GW27D, GW45D, and GW48D in the April 1986 samples. A similar situation had occurred in the initial 1984-85 field program, wherein GW36D (TNT Manufacturing Area) contained trace levels of 2,4,6-TNT. It was believed that the low levels of contaminants in GW36D had been carried from the contaminated shallow aquifer into the deep aquifer. Resampling of GW36D in April 1986 indicated that no detectable contamination was present in the deep aquifer at this location.

Resampling of the deep monitor wells was conducted in August 1986. In addition to the conventional sampling of GW45D, GW48D, and DGHW, time-series sampling was conducted at GW27D. Well GW27D was pumped continuously for 48 hours and was sampled at periodic time steps throughout the pumping. In this manner, successive pumped samples represent ground water quality at increasing distances from the pumped well (Keely and Wolf, 1983). The pattern of contaminant arrival, concentration, and duration provided data relevant to the presence, strength, and location of the contaminant source. In addition to GW27D, GW27 was sampled at similar time steps.

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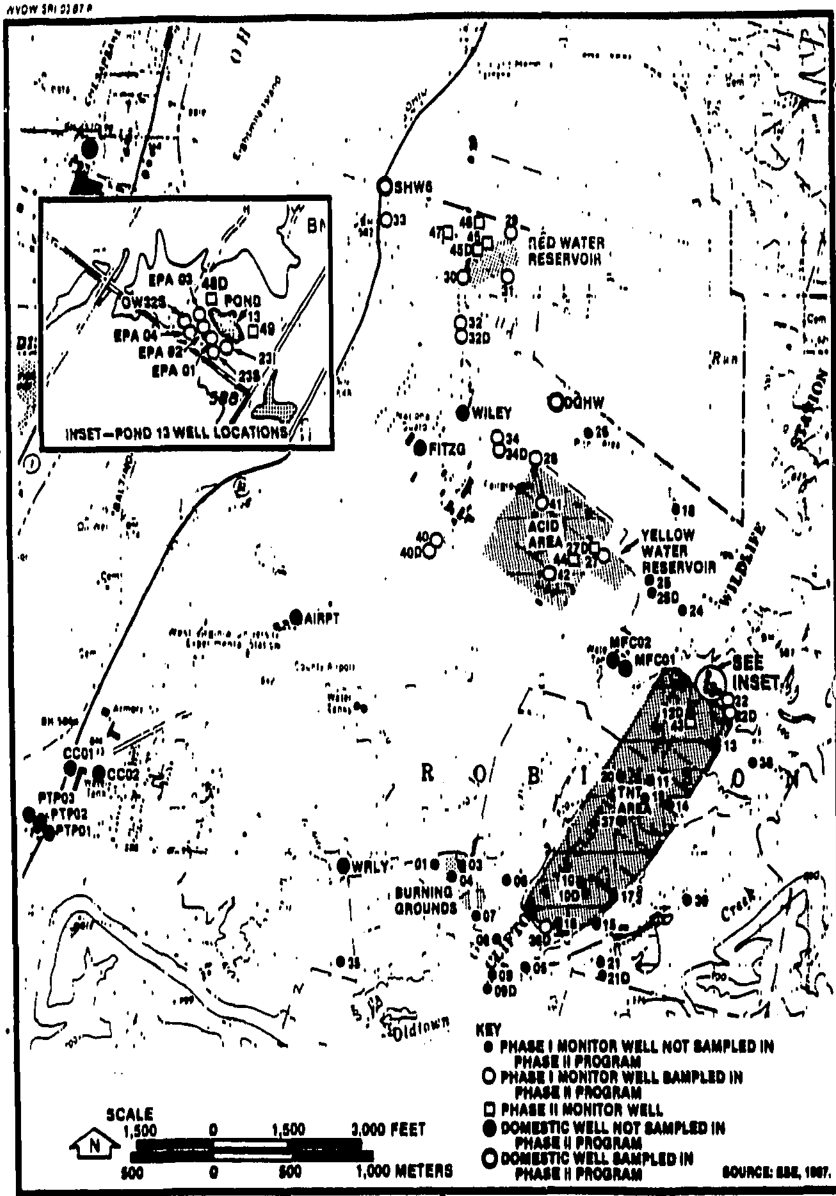

Figure 2.4-1
LOCATIONS OF WELLS SAMPLED DURING PHASE II

WEST VIRGINIA ORDNANCE WORKS
Supplemental Remedial Investigation
Phase II Field Program

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During the time-series sampling, Well GW27D was pumped with a submersible pump; the pump intake was located approximately 4 ft above the bottom of the well. Periodically during the sampling, the pump was slowly raised while pumping to mix the water column in the well bore. Each sample was collected with a dedicated bottom-filling 2-inch diameter PVC bailer. The bailer was submerged approximately 5 to 10 ft in the water column for sample collection. The pump was running when samples were collected. Prior to initiation of pumping, a sample was collected in Wells GW27D and GW27. Since these wells had not been pumped, the water sample may not have been representative of true aquifer composition.

Summary in situ measurements regarding well sampling are shown in Table 2.4-1. Laboratory analysis methods followed the procedures described in App. D of the initial RI report (ESE, 1986d). Details of sample containers, sample volumes, and preservation techniques followed the procedures described in App. E of the initial RI report (ESE, 1986d).

The matrix of parameters analyzed in the ground water sampling program is shown in Table 2.4-2.

Table 2.4-1. Phase II Ground Water Sampling Summary

Well Designation	Parameter* pH	Conductivity (umho/cm)	Temperature (°C)	Well Purging Equipment+	Number of Well Volumes Removed**
April 1986 Sampling					
GW22	6.5	167	16.4	B	5.1
GW22D	6.6	154	15.3	B	5.4
GW23S	6.3	236	12.9	C	9.6
GW23I	5.8	133	13.7	C	5.1
GW27	5.3	126	14.0	C	6.1
GW27D	6.6	212	15.2	B	7.0
GW28	5.4	065	12.4	C	5.7
GW29	6.0	243	15.3	B	7.4
GW30	5.8	214	13.8	B	16.0
GW31	5.7	225	13.7	B	6.7
GW32	6.2	212	16.9	C	5.0
GW32D	6.8	196	12.0	B	6.6
GW33	6.7	606	12.3	A	5.1
GW34	5.3	430	14.8	C	7.2
GW34D	6.5	205	14.8	B	6.4
GW36D	6.9	226	13.5	B	6.0
GW40	5.0	207	13.8	B	5.4
GW40D	6.5	187	14.6	B	5.4
GW41	5.4	205	13.6	C	5.7
GW42	5.3	055	13.7	C	8.3
GW43	5.0	075	12.4	B	7.3
GW44	5.9	086	14.3	C	6.0
GW45	5.8	264	15.2	B	5.7
GW45D	8.0	287	15.3	B	5.4
GW46	6.3	286	15.2	B	8.4
GW47	6.1	401	13.8	B	13.3
GW48D	6.7	178	16.0	B	5.9
GW49	5.8	059	13.5	C	7.1
EPA01	6.4	188	20.2	C	5.4
EPA02	5.9	221	14.0	C	10.4
EPA03	6.6	184	12.2	A	5.7
EPA04	6.3	716	14.7	C	5.6
SHW6	7.3	500	16.6	B	5.[illegible]

Table 2.4-1. Phase II Ground Water Sampling Summary
(Continued, Page 2 of 2)

Well Designation	Parameter* pH	Conductivity (umho/cm)	Temperature (^{o}C)	Well Purging Equipment+	Number of Well Volumes Removed**
August 1986 Sampling-Time Series Sampling: GW27D, GW27++					
GW27D-1	8.3	180	17.0	A	0.0
GW27D-2	8.0	201	18.0	B	1.0
GW27D-3	7.0	209	16.0	B	5.0
GW27D-4	7.3	215	15.5	B	4 hr***
GW27D-5	6.9	220	14.0	B	8 hr***
GW27D-6	9.1	265	16.0	B	24 hr***
GW27D-7	9.2	280	17.0	B	48 hr***
GW27-1	6.6	089	16.5	A	0.0
GW27-2	5.9	088	16.2	A	0.0
GW27-3	6.0	094	16.0	A	0.0
GW27-4	6.4	110	14.0	A	0.0
GW27-5	6.3	110	13.0	A	0.0
GW27-6	6.9	102	16.0	A	0.0
GW27-7	6.1	102	16.2	A	0.0
August 1986 Sampling--Single Well Sampling					
GW41	5.4	175	14.0	C	7.0
GW44	6.1	057	14.0	C	6.1
GW45	6.4	210	15.0	B	9.8
GW45D	8.1	232	16.0	B	5.4
GW47	6.5	291	16.0	B	7.1
GW48D	6.6	136	16.0	B	6.3
DGHW	6.8	250	16.5	D	5.2

*Measured at end of presampling purging.
+Well purging equipment:
A = dedicated PVC bailer. C = 2-inch centrifugal pump.
B = 3-inch submersible pump. D = permanent pump in well.
**Well volume--standing water in well casing plus saturated annulus (30-percent porosity).
++Pumping rate of GW27D was 8 to 9 gallons per minute; GW27 was not pumped. Note that subsamples 1 through 7 for GW27 were taken concurrently with subsamples 1 through 7 from GW27D.
***Refers to elapsed time of pumping GW27D during time-series sampling.

Note: umho/cm = micromhos per centimeter.
^{o}C = degrees Celsius.

Source: ESE, 1987.

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Table 2.4-2. Ground Water Sample Analysis Schedule

Well Designation	Type of Chemical Analysis* April 1986	August 1986
GW22	A	--
GW22D	A	--
GW23S	A	--
GW23I	A	--
GW27	A	A
GW27D	A	A,B,C,D,E,F,G
GW28	A	--
GW29	A	--
GW30	A	--
GW31	A	--
GW32	A	--
GW32D	A	--
GW33	A	--
GW34	A	--
GW34D	A	--
GW36D	A	--
GW40	A	--
GW40D	A	--
GW41	A	A
GW42	A	--
GW43	A	--
GW44	A	A

Table 2.4-2. Ground Water Sample Analysis Schedule
(Continued, Page 2 of 2)

Well Designation	Type of Chemical Analysis* April 1986	August 1986
GW45	A	A
GW45D	A	A,B,C,D,E,F,G
GW46	A	--
GW47	A	A
GW48D	A	A,B,C,D,E,F,G
GW49	A	--
EPA01	A	--
EPA02	A	--
EPA03	A	--
EPA04	A	--
SHW6	A	--
DGHW	A	A,B,C,D,E,F,G

* A = Nitroaromatics [nitrobenzene, 1,3-dinitrobenzene (1,3-DNB), 1,3,5-TNB, 2,4-DNT, 2,6-dinitrotoluene (2,6-DNT), and 2,4,6-TNT].
B = Nitrite plus nitrate as nitrogen.
C = Total alkalinity.
D = Bicarbonate alkalinity.
E = Bicarbonate ion.
F = Carbonate alkalinity.
G = Carbonate ion.
-- = Not sampled.

Source: ESE, 1986a.

2.5 SEDIMENT SAMPLE COLLECTION PROGRAM

As stated in Sec. 2.1.1, six sediment samples were collected in the Red Water Reservoirs. Sediment samples were collected by using a stainless-steel bucket auger. Vertical composite samples were collected in each borehole at an interval below that which had been sampled in the initial RI field program. The purpose of the sampling was to provide additional data regarding the vertical distribution of nitroaromatics and to refine the contaminant source strength at Ponds 1 and 2. Sample handling, sample containers, volumes, and preservation techniques followed the procedures described in App. E of the initial RI report (ESE, 1986d). Sediment samples were analyzed for nitroaromatics as described in App. D of the initial RI report (ESE, 1986d).

3.0 GROUND WATER HYDROLOGY

3.1 REVIEW OF AREAWIDE HYDROGEOLOGY FOR THE ACIDS AREA/YELLOW WATER RESERVOIR, RED WATER RESERVOIRS, AND POND 13/WET WELL AREA--PHASE I SURVEY

3.1.1 AQUIFER CHARACTERISTICS

In the Phase I RI field program, a number of distinct hydrogeologic flow systems were characterized at WVOW. In the Acids Area/Yellow Water Reservoir, the shallow aquifer consists of a medium- to coarse-grained sand containing approximately 5- to 10-percent gravel. This sand is overlain by a silty clay layer varying in some areas to clay and ranging in thickness from approximately 10 to 15 ft. The sand aquifer is uniform in texture and gradation throughout the area. Two apparently discontinuous clay and silty clay layers were observed in monitor wells screened in the shallow aquifer beneath the Acids Area/Yellow Water Reservoir area. The clay layers do not form a continuous confining layer, and the sand aquifer exists in an unconfined or semiconfined state. In deep monitor wells drilled at the adjacent north and south powerhouses, a gray clay with textural and physical characteristics similar to the gray clay confining layer observed in the first operable unit (TNT Manufacturing Area and Burning Grounds Area) was encountered.

At the Red Water Reservoirs, surface sediment consists primarily of silty clay extending to a 10- to 15-ft depth. At two of the monitor wells, the clay is overlain by a medium-grained sand. A second sequence of clays and silty clays is present and varies in thickness from 2 ft at GW29 to 20 ft at GW32. As shown in the geologic cross section for the Red Water Reservoirs, a high degree of lithologic variation (both areally and vertically) is present at this area of concern. Sand and clay units are both generally discontinuous over this area of concern with the exception of one continuous water-bearing sand unit (the shallow alluvial aquifer) at elevation 580 feet above mean sea level (ft-MSL).

AR304576

In addition to the wells drilled in the vicinity of the Red Water Reservoirs, five wells were drilled along the red water sewerline. In these wells, the top 2 to 5 ft of sediment consists of fine-grained materials, below which are fine- to coarse-grained sands. At one well pair, GW25 and GW25D, a silty fine sand was present from the surface elevation of 634 ft-MSL to elevation 606 ft-MSL. A silty clay confining layer occurred at elevation 591 ft-MSL. Below this clay, a second water-bearing sand unit occurred until the well was terminated at elevation 573.5 ft-MSL.

At the Pond 13/Wet Well Area, two markedly different hydrogeologic environments are present in the area surrounding Pond 13. At Pond 13, near-surface sediments consist of a thin veneer (5 to 10 ft) of sandy, silty clay underlain by a permeable, water-bearing shallow aquifer. At GW23I, the shallow aquifer is underlain by a thin clay layer, the areal extent of which is unknown. A second sand layer occurs below this clay layer; below this second sand layer, interbedded fine-grained sediments are present. In the lowermost portion of GW23I, the same gray clay as noted in the TNT Manufacturing Area was encountered, although the borehole extended only a short distance into the clay.

In contrast, the sediments encountered at nearby Wells GW22 and GW22D indicate a markedly different hydrogeologic environment. At these wells, the first permeable zone was not encountered until 526 ft-MSL, approximately 60 ft below ground surface. The gray clay confining layer is present beginning at 560-ft MSL and extending 25 ft in thickness. The distance between GW23I and GW22D is approximately 300 ft. The actual boundary between these two lithologic and hydrogeologic environments is not known.

The shallow aquifer at the Acids Area/Yellow Water Reservoir and the shallow aquifer along the red water sewerline are similar in lithologic and textural characteristics and represent similar depositional environments. At Pond 13, the physical characteristics of the shallow sand aquifer in the immediate vicinity of the pond are similar to the TNT Manufacturing Area shallow aquifer; however, the hydrogeologic environment changes abruptly to an extensive clay deposit at ground surface at GW22.

In the deep monitor wells drilled throughout the site, the majority of wells were screened in sediments of alluvial origin (e.g., GW25D and GW12D). Several wells such as GW21D and GW32D encountered glacial outwash material. According to published information (Wilmoth, 1966), the glacial outwash aquifer represents a single, continuous aquifer system. However, given the limited number of wells which penetrated the glacial outwash aquifer throughout the site during the Phase I investigation, it was not possible to verify this information.

3.1.2 GROUND WATER/SURFACE WATER INTERACTION

The interaction of ground water flow systems with surface water flow throughout the site was assessed in the initial RI survey by the use of a stream gaging program coupled with information obtained from selected monitor wells installed adjacent to surface water drainage flow systems. For those areas on the site with adjacent surface water gaging stations and monitor wells, comparison was made between surface water station elevations (from staff gage data) and the first permeable layer encountered during monitor well drilling. These data are presented in Table 3.1-1. For comparison purposes, surface water station elevations from measurements collected on Oct. 16, 1984; Jan. 7, 1985; Mar. 11, 1985; and Apr. 22, 1986, are included. These data show that the range of surface water elevations varies less than 3 ft throughout the study.

The extensive surficial clay deposits found in the southern portions of the site are not present in the northern portion; however, surface water elevations at stations MC1, MC5, P2, P3, and P13 are identical to or lower than the elevations of the first permeable layer encountered in the adjacent monitor wells. However, during the October 1984 gaging, no flow

Table 3.1-1. Comparison of Surface Water Station Elevations and Elevations of First Permeable Layer Encountered in Adjacent Monitor Wells

Area of Concern	Surface Station Identification	Elevation of Surface Water (ft-MSL) 10/16/84	01/07/85	03/11/85	04/22/86	Adjacent Monitor Well	Elevation of Permeable Layer (ft-MSL)	ΔX*
Red Water Reservoirs	MC1	568.5	568.4	568.9	566.0	GW33	576.0	-7
Red Water Reservoirs	MC2	581.9	582.1	582.7	582.3	GW32	564.2	+17
Acids Area/ Yellow Water Reservoir	MC5	596.1	596.5	596.5	596.4	GW28	595.8	0
Red Water Reservoirs	P1	602.2	603.0	603.2	602.4	GW30	591.8	+10
Red Water Reservoirs	P2	599.9	600.7	600.8	601.0	GW31	606.9	-7
Pond 13/ Wet Well Area	P13	586.5	588.4	588.8	588.9	GW23S/ GW23I	586.4/ 585.2	0

*ΔX = (surface water station elevation) - (elevation of first permeable layer encountered in monitor well construction).

Sources: ESE, 1986a, d.

AR304579

was occurring at Station MC5 (Acids Area); therefore, baseflow into this system was negligible at this station although an interconnection between MC5 and the permeable layer encountered at GW28 would be expected based on elevation comparisons with GW28. No flow was observed downstream at MC3. At the Red Water Reservoirs, the water-table elevation at GW31 (adjacent to P2) during a high-flow period was 18 ft below the elevation of surface water at P2. At Pond 13, surface water levels were coincident with the observed water levels at Wells GW23S and GW23I.

The hydrologic interconnection present from the intersection of surface drainage with the permeable strata at these portions of the site suggests that, as ground water elevations increase, a significant ground water component should be present in flows observed in Mill Creek.

In most ponds at the site, ground water discharge into the ponds or recharge by the ponds into the ground water is also substantially minimized by the presence of extensive clay deposits in the pond bottoms. Sediment grab samples (approximately 6 to 8 inches in depth) and sediment core samples (1 to 3 ft in depth) in the ponds consisted primarily of stiff clay with a thin, overlying layer of decomposed, organic, detrital material. In many cases, field observations indicated that the bottom portion of even the shallow (6- to 8-inch) core ranged in moisture content from dry to slightly moist, whereas sediments in the top 1 to 2 inches of the core were wet. During the October 1984 gaging, no surface water outflow was occurring from any of the ponds. Because of the lack of interconnection with the ground water, the potential for input to or output from the ponds is generally small. However, rising ground water levels and surface runoff during a wet season greatly increase the potential for ground water discharge to the northern ponds.

In the northern portions of WVOW, the Mill Creek flow system receives ground water discharged during high-flow conditions. The Mill Creek stations are downstream from both a treatment plant and Pond 16. Pond 16 is located immediately upgradient of the Red Water Reservoirs. The results of the Phase I RI study indicate that Pond 16, through leakage, recharges the shallow aquifer at the Red Water Reservoirs.

AR304580

3.2 OVERVIEW OF METHODOLOGY AND AQUIFER CHARACTERISTICS EMPLOYED IN THE PHASE II SURVEY

The purpose of the hydrogeological assessment was to characterize the ground water flow system(s) at each area of concern to identify characteristics relevant to the definition of contaminant migration pathways. The overall objectives of the hydrogeologic program by area of concern are presented in Sec. 1.1.

The hydrogeologic analysis is presented on an area-by-area basis for the areas of concern at WVOW. In each subsection, results of the geotechnical program are presented to characterize the individual aquifers present at each area of concern, describe aquifer properties, and assess contaminant migration pathways.

For an overall perspective of the monitoring network installed at WVOW, the locations of observation wells are shown in Fig. 3.2-1, and the locations of monitor wells installed by ESE and EPA and municipal/domestic supply wells are shown in Fig. 3.2-2. To identify aquifers present at each area of concern, the data produced during the drilling program were used to prepare geologic cross sections for each area of concern. The locations of the geologic cross sections for the overall project area are shown on Fig. 3.2-3. Well construction summaries for each of the monitor wells are shown in Table 3.2-1.

Water-level measurements were taken for all observation wells and monitor wells throughout the study for determination of hydraulic gradients. Ground water elevation data are summarized in Tables 3.2-2 and 3.2-3.

Various methods of aquifer testing were employed in the Phase I study to determine aquifer characteristics at each area of concern. The aquifer testing program encompassed all areas at WVOW. Since the Phase I data base provided sufficient data at the Acids Area/Yellow Water Reservoir, Red Water Reservoir, and Pond 13/Wet Well Area, additional aquifer

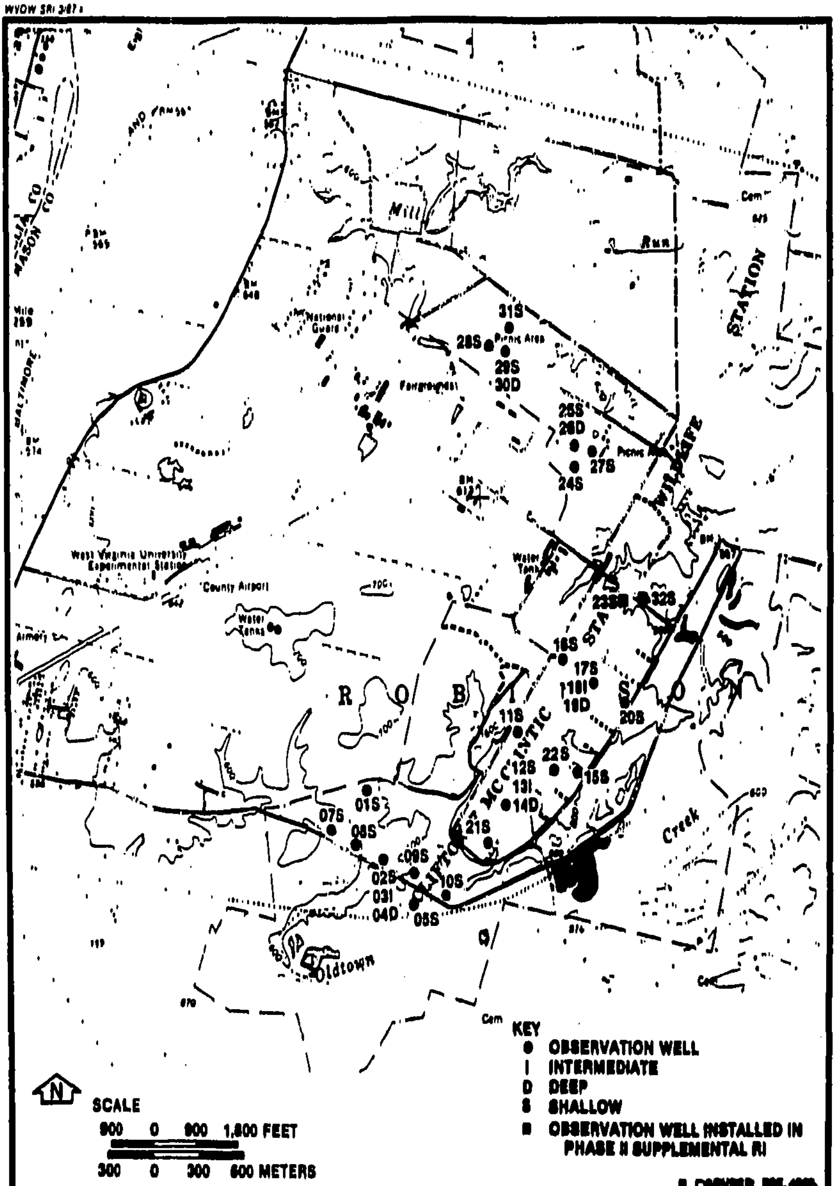

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Figure 3.2-1
LOCATIONS OF WATER-LEVEL OBSERVATION WELLS

WEST VIRGINIA ORDNANCE WORKS
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WVOW SRI 3/87 A

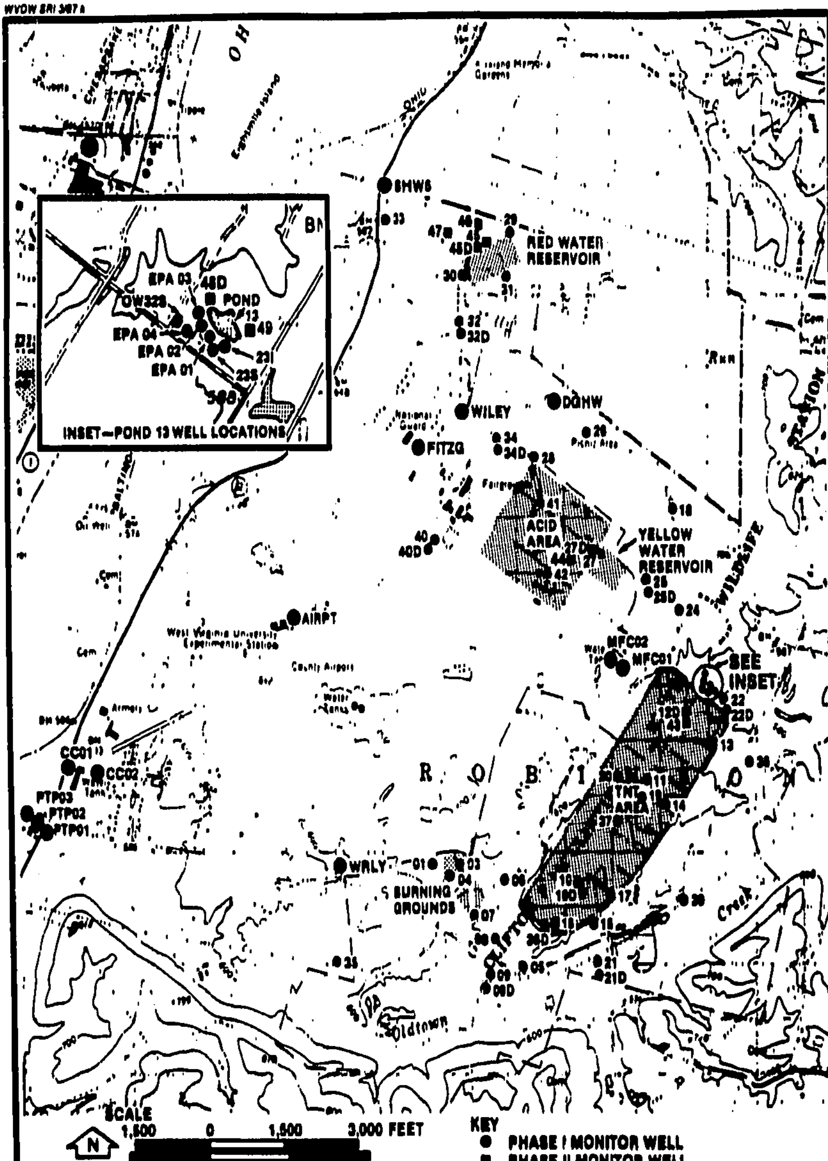

Figure 3.2-2
LOCATIONS OF MONITOR WELLS, EPA WELLS, AND OFFSITE DOMESTIC WELLS

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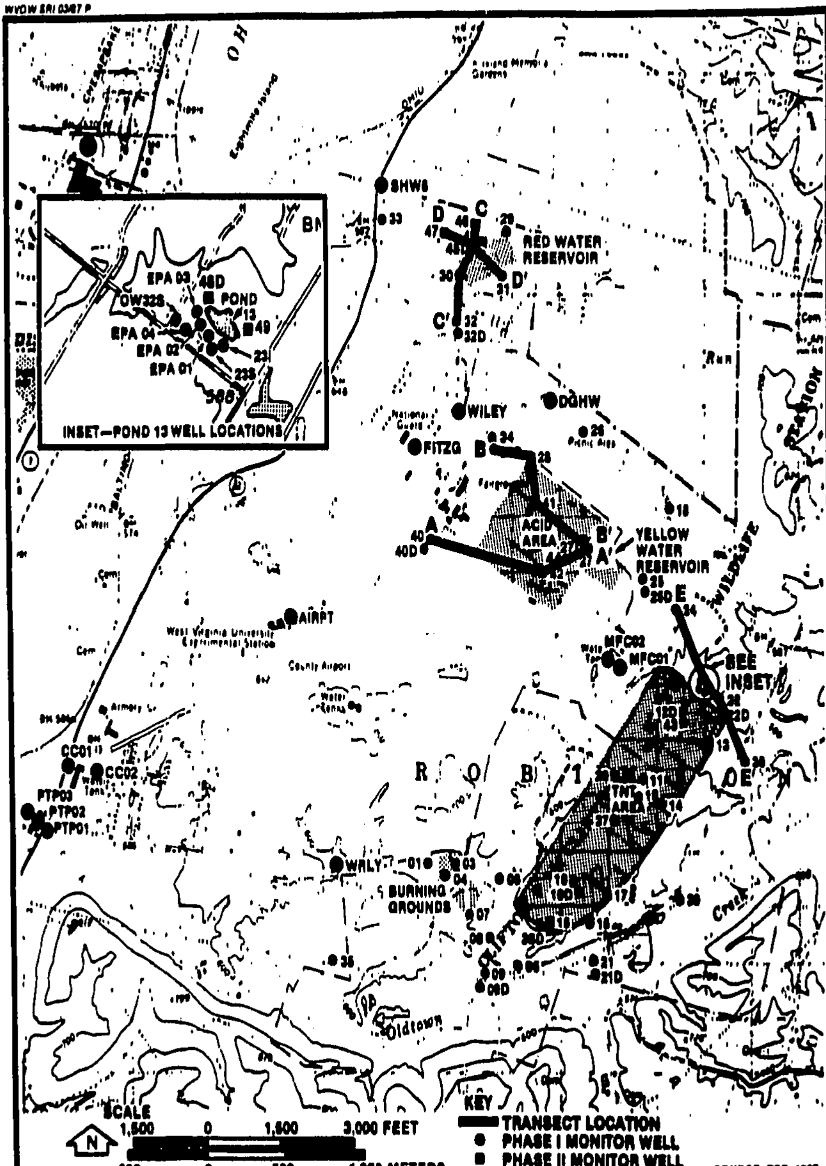

Figure 3.2-3
GEOLOGIC CROSS-SECTION INDEX MAP

WEST VIRGINIA ORDNANCE WORKS
Supplemental Remedial Investigation
Phase II Field Program

Table 3.2-1. Monitor Well Construction—Phase I and Phase II

Well Designation	Installation Date*	Total Borehole Depth	Depth of Casing and Screen	Screened Interval	Filter Pack Interval	Bentonite Interval	Type of Drilling Rig†
Phase I Monitor Wells							
GW1	10/24-10/25	91.5	89.70	74.7-89.7	69-90	64-69	C
GW3	10/25-10/25	28.5	28.5	13.35-28.35	9-28.5	4-9	C
GW4	10/21-10/22	46.5	46.5	31.5-46.5	26.5-46.5	21.5-26.5	C
GW5	11/26-11/27	67.0	66.98	51.98-66.48	46-67	41-46	C
GW6	11/06-11/07	45.0	43.8	28.8-43.8	23-45	17.5-23	C
GW7	10/29-10/31	87.0	87.0	72-87	64-87	58-64	C
GW8	10/29-10/29	30.5	29.2	14.2-29.2	9-30.5	5-9	C
GW9	10/27-10/27	35.0	34.2	19.2-34.2	14-35	9-14	C
GW9D	10/26-10/27	82.7	82.7	67.7-82.7	61.5-82.7	56.5-61.5	C
GW10	10/16-10/16	31.55	31.55	16.55-31.55	11.25-31.55	6.25-11.25	C
GW10D	10/15-10/16	90.0	89.85	74.85-89.85	70-90	65-70	C
GW11	10/17-10/17	37.5	37.0	22-37	15-37	10-15	C
GW12D	10/19-10/21	95.0	94.45	79.45-94.45	75-95	70-75	C
GW13	10/21-10/22	46.0	40.0	25-40	20-40	15-20	A
GW14	10/19-10/19	32.5	32.40	17.4-32.4	12.4-32.4	7.4-12.4	C
GW15	11/13-11/14	24.0	24.0	14.0-24.0	8.5-24.0	3-8.5	A
GW16	10/24-10/24	24.5	15.3	10.3-15.3	5.5-24.5	2.3-5.5	A
GW17	10/24-10/24	28.0	27.0	12.0-27.0	7-28	2-7	A
GW18	11/15-11/15	15.5	14.0	4.0-14.0	3-15.5	1-3	A
GW19	10/18-10/18	32.0	31.5	16.5-31.5	11.5-32	6.5-11.5	C
GW20	10/18-10/18	37.8	37.8	22.8-37.8	17.8-37.8	11.8-17.8	C
GW21	10/25-10/25	27.0	25.7	15.7-25.7	10.7-27	5.7-10.7	A
GW21D	11/07-11/08	60.0	59.7	44.7-59.7	40-60	35-40	C
GW22	10/13-10/14	70.6	70.6	55.6-70.6	50-70.6	45-50	C
GW22D	10/08-10/12	106	105.75	90.75-105.75	85.75-105.75	80.75-85.75	C
GW23S	10/30-10/30	16.0	14.5	4.5-14.5	3-16	1-3	A
GW23I	10/30-10/31	29.5	24.5	9.5-24.5	4.5-29.5	1.5-4.5	A
GW24	11/01-11/01	24.5	24.0	9-24	5-24.5	1-5	A
GW25	11/11-11/11	29.0	29.0	14-29	9-29	4-9	C
GW25D	11/08-11/11	60.5	60.0	45-60	39-60	33-39	C
GW26	11/02-11/02	24.5	23.0	13-23	8-23	3-8	A
GW27	10/20-10/21	40.0	38.5	23.5-38.5	15.5-40	10.5-15.5	A
GW28	11/02-11/02	24.5	24.0	9-24	5-24.5	1-5	A
GW29	10/16-10/17	49.0	45.4	30.4-45.4	25.4-49	20.4-25.4	A
GW30	10/18-10/18	41.0	35.5	25.5-35.5	20.5-41	15.5-20.5	A
GW31	10/17-10/18	47.0	46.5	26.5-46.5	21.5-47.0	16.5-21.5	A
GW32	10/19-10/20	41.0	38.0	23-38	15-41	10-15	A
GW32D	11/29-11/30	66.0	66.0	51-66	46-66	[illegible]	C
GW33	12/01-12/01	25.0	22.5	7.5-22.5	6-25	[illegible]	C

Table 3.2-1. Monitor Well Construction—Phase I and Phase II (Continued, Page 2 of 2)

Well Designation	Installation Date*	Total Borehole Depth	Depth of Casing and Screen	Screened Interval	Filter Pack Interval	Bentonite Interval	Type of Drilling Rig†
Phase I Monitor Wells (Continued)							
GW34	11/14-11/14	34.5	34.5	14.5-34.5	8.5-34.5	3-8.5	A
GW34D	11/12-11/14	114	114	99-114	87-114	82-87	C
GW35	10/31-11/01	44.5	44.5	29.5-44.5	24.5-44.5	19.5-24.5	A
GW36D	11/27-11/29	92.8	92.8	77.8-92.8	72-92.8	67-72	C
GW37	11/12-11/13	35.0	32.5	22.5-32.5	17-32.5	11-17	A
GW38	11/05-11/06	36.0	32.5	17.5-32.5	12-36	7-12	A
GW39	11/06-11/07	32.0	30.0	10-30	7.5-32	2.5-7.5	A
GW40	11/16-11/16	38.5	37.3	22.3-37.3	16.5-38.5	11-16.5	A
GW40D	11/16-11/17	90.5	90.5	70.5-90.5	65-90.5	60-65	C
GW41	11/03-11/03	27.0	26.0	11-26	6-27	1.5-6	A
GW42	11/08-11/08	25.0	24.3	9.3-24.3	5-25	1-5	A
Phase II Monitor Wells							
GW27D	3/30-4/1	104.0	102.5	87.5-102.5	81-104	76-81	C
GW43	3/12-3/12	35.5	35.0	20-35	14.7-35.5	9.7-14.7	C
GW44	4/2-4/2	36.5	35.0	20-35	15-36.5	10-15	C
GW45	3/16-3/17	56.5	55.0	40-55	32-56.5	26-32	C
GW45D	3/13-3/16	106.5	106.0	91-106	83.5-106.5	77.5-83.5	C
GW46	3/17-3/18	56.5	55.0	40-55	34-56.5	28-34	C
GW47	4/2-4/3	65.0	64.0	49-64	44-65	39-44	C
GW48D	3/21-3/23	110.0	107.0	87-107	81-110	76-81	C
GW49	3/18-3/19	36.5	34.0	19-34	13.5-36.5	8-13.5	C

Note: All measurements are feet from ground surface.

*Phase I monitor wells were installed in 1984; Phase II wells in 1986.
†Type of drilling rig:
A = hollow-stem auger, and
C = cable tool.

Sources: ESE, 1986a, d.

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Table 3.2-2. Ground Water Levels for Monitor Wells—Phase I and Phase II

Well Designation	Ground Water Elevations (ft-MSL)					
	Before Development	After Development (24-hour)	01/07/85*	03/11/85	4/22/86*	08/11/86†
Phase I Monitor Wells						
GW1	568.90	568.33	570.27	586.07**	570.12	††
GW3	586.18	587.32	586.47	589.50	589.26	††
GW4	587.46	587.26	589.25	589.84	589.49	††
GW5	573.20	573.92	574.67	574.80	574.39	††
GW6	574.85	574.25	576.09	576.67	576.77	††
GW7	566.97	565.87	568.04	568.03	567.80	††
GW8	574.74	575.40	576.85	579.11	579.43	††
GW9	564.08	565.08	566.69	567.28	567.00	††
GW9D	566.18	565.63	567.71	568.16	567.72	††
GW10	595.34	595.69	595.36	595.96	595.59	††
GW10D	585.26	585.93	586.27	586.37	585.87	††
GW11	595.85	595.90	595.88	596.06	595.87	††
GW12D	589.43	589.33	590.61	591.00	590.29	††
GW13	594.38	590.88*	592.70	592.70	592.66	††
GW14	594.43	593.93	594.38	594.64	594.64	††
GW15	593.47	593.17	593.61	593.98	594.01	††
GW16	593.89	593.49*	594.30	594.49	594.51	††
GW17	592.54	592.42	593.03	593.33	593.28	††
GW18	614.09	614.31	615.19	615.60	615.12	††
GW19	595.73	595.74	595.73	595.79	595.64	††
GW20	596.37	596.39	596.58	596.90	597.64	††
GW21	565.92	564.15	571.26	571.61	571.55	††
GW21D	Flowing	Flowing	580.76	††	579.20	††
GW22	587.43	587.57	588.47	588.38	587.97	††
GW22D	Flowing	Flowing	589.35	††	589.20	††
GW23S	588.08	587.96	588.66	588.76	588.59	††
GW23I	588.56	588.82	589.18	589.42	588.98	††
GW24	615.68	615.68	616.38	617.58	617.49	††
GW25	616.33	616.13	616.88	617.56	617.88	††
GW25D	597.15	596.65	598.30	597.92	597.80	††
GW26	612.78	612.80	613.71	615.56	615.66	††
GW27	597.15	597.04	597.34	597.53	597.29	596.83
GW28	595.84	595.78	596.80	597.23	596.64	595.91
GW29	576.07	576.07	575.23	575.93	577.27	576.80
GW30	581.86	581.86	581.41	581.97	582.54	582.21
GW31	582.28	582.28	582.78	584.29	585.28	583.26
GW32	579.81	579.51	580.66	581.37	582.41	[illegible]
GW32D	576.79	577.39	577.86	578.55	579.54	578.64

Table 3.2-2. Ground Water Levels for Monitor Wells--Phase I and Phase II (Continued, Page 2 of 2)

Well Designation	Ground Water Elevations (ft-MSL) Before Development	After Development (24-hour)	01/07/85*	03/11/85	4/22/86*	08/11/86†
Phase I Monitor Wells (Continued)						
GW33	568.59	569.59	569.79	569.02	568.59	567.66
GW34	594.13	594.93	595.03	595.32	594.78	594.31
GW34D	587.03	583.33	586.78	586.99	588.38	587.07
GW35	564.11	563.46	565.83	565.06	564.84	††
GW36D	574.84	575.23	576.13	576.24	575.87	††
GW37	594.76	595.31	595.56	592.22	595.62	††
GW38	580.19	581.92	581.74	580.92	581.47	††
GW39	578.41	577.66	578.31	578.25	577.90	††
GW40	595.12	594.72	595.72	595.78	595.32	595.02
GW40D	594.61	593.51	594.63	594.62	594.28	593.91
GW41	581.50	581.42	596.86	597.13	596.57	596.05
GW42	593.82	596.16	596.54	596.64	596.37	596.06
EPA01	†††	†††	588.42	588.58	588.64	††
EPA02	†††	†††	585.68	585.86	588.64	††
EPA03	†††	†††	588.90	587.83	588.67	††
EPA04	†††	†††	589.11	588.18	588.63	††
Phase II Monitor Wells						
GW43	595.02	594.97	††	††	594.85	††
GW44	596.98	596.94	††	††	596.92	596.37
GW45	571.90	571.88	††	††	572.10	572.14
GW45D	567.74	567.63	††	††	569.09	567.88
GW46	567.61	567.56	††	††	567.81	567.99
GW47	562.85	562.35	††	††	564.00	563.11
GW48D	589.47	589.45	††	††	590.47	††
GW49	589.56	589.41	††	††	589.46	††
GW27D	595.82	595.78	††	††	596.62	596.10

*Stabilized ground water circuit.
†Wells GS29, GW30, GW31, GW32, GW32D, GW45D, GW46, GW47 measured on 8/14/86.
**Probable measurement error.
††Not measured.
***Not a 24-hour measurement.
†††Existing wells, not developed.

Sources: ESE, 1986a, d.

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Table 3.2-3. Ground Water Levels for Observation Wells—Phase I and Phase II

Well Designation	Ground Water Elevation (ft-MSL) 10/10/84	10/25/84	11/18/84	01/07/85*	03/11/85	04/22/86*
OW01S	596.23	595.93	596.83	596.70	596.91	597.19
OW02S	593.20	592.46	593.17	603.66	604.24	600.44
OW03I	569.14	568.94	569.62	573.69	575.40	571.78
OW04D	566.19	566.05	566.39	567.09	568.08	567.00
OW05S	565.95	565.91	566.34	569.10	567.27	568.24
OW07S	590.21	590.22	590.17	589.43	588.39	589.49
OW08S	590.92	590.81	590.85	596.26	598.30	596.52
OW09S	574.65	574.35	574.74	577.09	578.95	578.64
OW10S	570.89	571.08	571.65	573.36	573.35	572.83
OW11S	596.85†	605.78**	596.59	596.42	596.66	596.42
OW12S	596.06	586.91	589.52	591.16	592.59	592.18
OW13I	595.01	594.92	594.83	594.56	595.17	594.67
OW14D	583.20**	596.07	597.25	595.75	596.01	595.80
OW15S	593.74	593.70	593.65	593.65	594.26	593.84
OW16S	597.30†	597.21	597.04	596.80	597.49	596.76
OW17S	595.71†	595.64	595.49	595.41	595.97	595.41
OW18I	595.93†	595.79	595.73	595.48	595.73	595.46
OW19D	595.54†	595.09	595.05	594.80	594.98	595.84
OW20S	594.59	594.53	594.48	594.32	594.47	594.49
OW21S	594.36	594.24	594.40	594.45	595.17	594.66
OW22S	595.17†	595.14	595.73	594.87	594.98	595.14
OW23S	592.72	592.71	592.91	592.94	593.16	592.69
OW24S	616.87	616.82	††	617.03	617.70	617.98
OW25S	616.37	616.97	††	616.27	616.98	617.42
OW26D	597.77	597.66	††	597.74	597.96	600.79
OW27S	617.19	617.01	††	617.09	617.76	618.14
OW28S	596.90	596.80	††	597.25	597.09	597.40
OW29S	612.76	612.66	††	613.16	614.45	614.58
OW30D	597.03	596.87	††	597.23	597.62	597.48
OW31S	613.46	613.32	††	613.81	616.10	615.76
OW32S***	††	††	††	††	††	586.99

*Stabilized ground water circuit.
†Taken October 11, 1984.
**Probable measurement error.
††Not measured.
***Phase II observation well.

Sources: ESE, 1986a, d.

AR304589

testing was not conducted during the Phase II supplemental RI field program. The following paragraphs describe the methods employed in the Phase I survey to derive aquifer characteristics.

Hydraulic conductivity was assessed for each area by employing slug tests and falling-head permeability tests and by using Hazen's rule. Data obtained from slug tests of selected shallow and deep wells throughout the site were analyzed using an ESE-developed, computer-assisted data management program to tabulate and plot data and calculate hydraulic conductivity using methodology described in Hvorslev (1951) and in Bouwer and Rice (1976). Calculated values for hydraulic conductivity are shown in Table 3.2-4.

In addition to the slug tests, alternative methods of calculating hydraulic conductivity were employed for comparison purposes. For 10 of the 20 wells evaluated by slug tests, composite sediment samples were obtained during drilling from the screened interval for each well. The composite samples were analyzed for moisture content, grain-size distribution, and falling-head permeability. Three trials of falling-head permeability values were arithmetically averaged for hydraulic conductivity. Individual values for the tests and average values (arithmetic means) are shown in Table 3.2-5. Grain-size distribution was determined by sieve analysis; from the grain-size distribution plot, hydraulic conductivity estimates were determined using Hazen's rule (Hazen, 1892). Hazen's method is applicable for uniformly graded sands and is essentially an empirical relationship which is based on the following power-law relation between conductivity and soil texture:

Table 3.2-4. Sediment Hydraulic Conductivity Properties

Well Designation	Slug Tests: I = Slug In, O = Slug Out	Hydraulic Conductivity (ft/sec): Slug Tests: Bouwer and Rice Method	Hydraulic Conductivity (ft/sec): Slug Tests: Hvorslev Method	Hydraulic Conductivity (ft/sec): Permeameter Test*	Hydraulic Conductivity (ft/sec): Hazen's Rule†	Moisture Content (percent of dry weight)
GW04	I	1.8×10^{-5}	2.5×10^{-5}	—	—	—
	O	1.5×10^{-5}	2.2×10^{-5}	—	—	—
GW06	I	1.4×10^{-5}	1.8×10^{-5}	—	—	—
	O	1.0×10^{-5}	1.5×10^{-5}	—	—	—
GW10	I	1.2×10^{-4}	5.8×10^{-4}	2.8×10^{-5}	1.2×10^{-4}	22.5
	O	2.7×10^{-4}	4.6×10^{-4}	—	—	—
GW10D	I	7.8×10^{-6}	1.0×10^{-5}	2.3×10^{-5}	5.2×10^{-5}	21.4
	O	7.8×10^{-6}	9.3×10^{-6}	—	—	—
GW15	I	1.1×10^{-4}	3.1×10^{-4}	2.0×10^{-4}	4.6×10^{-4}	22.9
	O	8.0×10^{-5}	1.1×10^{-4}	—	—	—
GW16	I	1.0×10^{-4}	1.8×10^{-4}	—	—	—
	O	1.1×10^{-4}	1.8×10^{-4}	—	—	—
GW19	I	1.7×10^{-4}	3.3×10^{-4}	5.6×10^{-5}	2.7×10^{-4}	26.9
	O	1.9×10^{-3}	2.5×10^{-3}	—	—	—
GW23I	I	2.4×10^{-5}	4.4×10^{-5}	1.6×10^{-7}	—	24.8
	O	2.3×10^{-5}	3.8×10^{-5}	—	—	—
GW25	I	1.0×10^{-4}	2.3×10^{-4}	1.2×10^{-4}	4.0×10^{-4}	24.5
	O	1.5×10^{-4}	1.8×10^{-4}	—	—	—
GW25D	I	2.7×10^{-4}	3.1×10^{-4}	7.9×10^{-5}	7.2×10^{-4}	28.7
	O	1.0×10^{-4}	1.4×10^{-4}	—	—	—
GW26	I	1.9×10^{-4}	3.1×10^{-4}	—	—	—
	O	2.2×10^{-4}	3.0×10^{-4}	—	—	—
GW27	I	3.7×10^{-4}	3.8×10^{-4}	3.3×10^{-5}	2.8×10^{-4}	24.8
	O	2.6×10^{-4}	3.5×10^{-4}	—	—	—
GW30	I	1.3×10^{-4}	3.0×10^{-4}	2.9×10^{-4}	7.2×10^{-4}	23.5
	O	1.6×10^{-4}	2.2×10^{-4}	—	—	

Table 3.2-4. Sediment Hydraulic Conductivity Properties (Continued, Page 2 of 2)

Well Designation	Hydraulic Conductivity (ft/sec) Slug Tests: I = Slug In, O = Slug Out	Slug Tests: Bouwer and Rice Method	Slug Tests: Hvorslev Method	Permeameter Test*	Hazen's Rule†	Moisture Content (percent of dry weight)
GW32	I	6.9×10^{-6}	1.0×10^{-5}	—	—	—
	O	3.9×10^{-6}	5.7×10^{-6}	—	—	—
GW32D	I	1.9×10^{-5}	3.9×10^{-5}	—	—	—
	O	1.7×10^{-5}	2.4×10^{-5}	—	—	—
GW34	I	9.1×10^{-5}	3.9×10^{-5}	—	—	—
	O	9.3×10^{-5}	1.4×10^{-4}	—	—	—
GW34D	I	5.3×10^{-6}	5.1×10^{-6}	—	—	—
	O	3.9×10^{-6}	4.0×10^{-6}	—	—	—
GW36D	I	3.6×10^{-5}	4.9×10^{-5}	—	—	—
	O	3.2×10^{-5}	4.0×10^{-5}	—	—	—
GW37	I	4.0×10^{-6}	6.1×10^{-6}	1.7×10^{-4}	1.0×10^{-3}	23.3
	O	4.5×10^{-6}	6.3×10^{-6}	—	—	—
GW41	I	2.6×10^{-4}	4.6×10^{-4}	—	—	—
	O	3.0×10^{-4}	5.1×10^{-4}	—	—	—

Note: — = Not analyzed.

*Falling-head permeability test [U.S. Army Engineer Waterways Experiment Station (WES), 1970]. Average of 3 trials except for GW15 (average of 4 trials).
†Hydraulic conductivity $K = Ad_{10}^2$, where: $A = 1.0$ when K is in centimeters per second (cm/sec) and d_{10} is in millimeters (mm); values converted to feet per second (ft/sec) (Freeze and Cherry, 1979).

Source: ESE, 1987.

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Table 3.2-5. Physical Analysis of Aquifer Sediments*

Well Designation	Moisture Content: Percent of Dry Weight†	Moisture Content: Percent of Total Weight	Permeability (cm/sec)†: Trial 1	Trial 2	Trial 3	Average
GW10	22.5	18.4	9.0×10^{-4}	8.3×10^{-4}	8.6×10^{-4}	8.6×10^{-4}
GW10D	21.4	17.6	7.3×10^{-4}	7.0×10^{-4}	6.9×10^{-4}	7.1×10^{-4}
GW15**	22.9	18.6	7.7×10^{-3}	5.8×10^{-3}	5.0×10^{-3}	6.1×10^{-3}
GW19	26.9	21.2	1.2×10^{-3}	1.9×10^{-3}	1.9×10^{-3}	1.7×10^{-3}
GW23I	24.8	19.8	3.5×10^{-6}	5.6×10^{-6}	5.2×10^{-6}	4.8×10^{-6}
GW25	24.5	19.7	3.8×10^{-3}	3.5×10^{-3}	3.3×10^{-3}	3.5×10^{-3}
GW25D	28.7	22.3	2.1×10^{-3}	2.6×10^{-3}	2.4×10^{-3}	2.4×10^{-3}
GW27	24.8	19.9	9.1×10^{-4}	1.1×10^{-3}	1.0×10^{-3}	1.0×10^{-3}
GW30	23.5	19.0	8.6×10^{-3}	8.8×10^{-3}	9.7×10^{-3}	9.0×10^{-3}
GW37	23.3	18.9	4.7×10^{-3}	5.7×10^{-3}	5.5×10^{-3}	5.3×10^{-3}

*Composite sample of sediment from the screened interval for each well obtained during drilling.
†Methodology for moisture content and falling-head permeability test from U.S. Army Engineer WES, 1970.
**For GW15, four trials were conducted, and the permeability for the fourth trial was 6.0×10^{-3}.

Source: ESE, 1986d.

$$K = Ad_{10}^2$$

where: K = hydraulic conductivity (cm/sec);
A = coefficient, equal to 1.0 when K is in centimeters per second and d is in millimeters; and
d_{10} = grain-size diameter (mm) at which 10 percent by weight of the soil particles are finer and 90 percent are coarser.

Hazen's approximation provides a rough estimate of hydraulic conductivity which can be used to confirm other methods of analysis (Freeze and Cherry, 1979). Hydraulic conductivity values obtained by this method are included in Table 3.2-4.

The physical analysis program also included moisture-content analysis. Methodology followed procedures described in U.S. Army Engineer Manual 1110-2-1906 (1970). The moisture-content values obtained are listed in Table 3.2-5; values for moisture content by dry weight can be used as an estimate of aquifer porosity (Fetter, 1980). For the purposes of the RI, moisture content values were employed in ground water flow rate calculations and were assumed to be equivalent to aquifer effective porosity.

The various methods described resulted in reliable estimates of hydraulic conductivity and porosity of aquifer materials which can be employed in contaminant migration rate calculations. The values obtained are measurements of aquifer properties in the immediate vicinity of the well bore (in the case of slug tests) or are values obtained from analysis of material from individual boreholes (physical analysis program). As such, the aquifer parameters obtained do not necessarily reflect areawide aquifer properties and should be considered accurate only to within one order of magnitude. As noted by Bouwer (1978), "...it is not uncommon to find that replicate tasks in seemingly uniform material yield K values that differ by an order of magnitude, especially if the material has a low permeability."

3.3 ACIDS AREA/YELLOW WATER RESERVOIR

3.3.1 REVIEW OF PHASE I RI RESULTS

As determined in the Phase I RI study, a single shallow sand aquifer under unconfined, or possibly semi-confined, conditions is present in this study area. The presence of the gray clay in this area could not be determined because no deep wells were drilled in the immediate vicinity of the Acids Area/Yellow Water Reservoir. In addition, the Phase I contamination assessment determined that the shallow aquifer in the vicinity of Wells GW27 and GW41 was contaminated by low levels of nitroaromatics. The nearest downgradient shallow aquifer well, GW42, was uncontaminated; however, the downgradient extent of shallow aquifer contamination could not be verified.

3.3.2 PHASE II RESULTS

To better define the horizontal extent of shallow aquifer ground water contamination, the Phase II investigation in this area included the installation of one additional shallow monitor well, GW44. As shown in Fig. 3.2-2, this well was located approximately midway between the contaminated shallow well, GW27, and the nearest uncontaminated shallow downgradient well, GW42. In addition, Well GW27D was drilled adjacent to Well GW27 at the Yellow Water Reservoir to verify the presence and thickness of the gray clay layer and to monitor ground water quality in the deep aquifer below the previously documented contamination in the shallow aquifer. It should be noted that Well GW27D was originally sited as 44D to avoid drilling through a high-risk area. However, due to problems with access, the well was relocated and the well designation was changed to 27D.

Based on the information obtained during drilling of GW27D and GW44, two geologic cross sections were prepared. As shown in the geologic cross-section index map for the Acids Area/Yellow Water Reservoir (Fig. 3.3-1), cross section A-A' extends approximately west-east, and cross section B-B' extends approximately northwest-southeast. These cross sections are shown in Fig. 3.3-2 and Fig. 3.3-3, respectively.

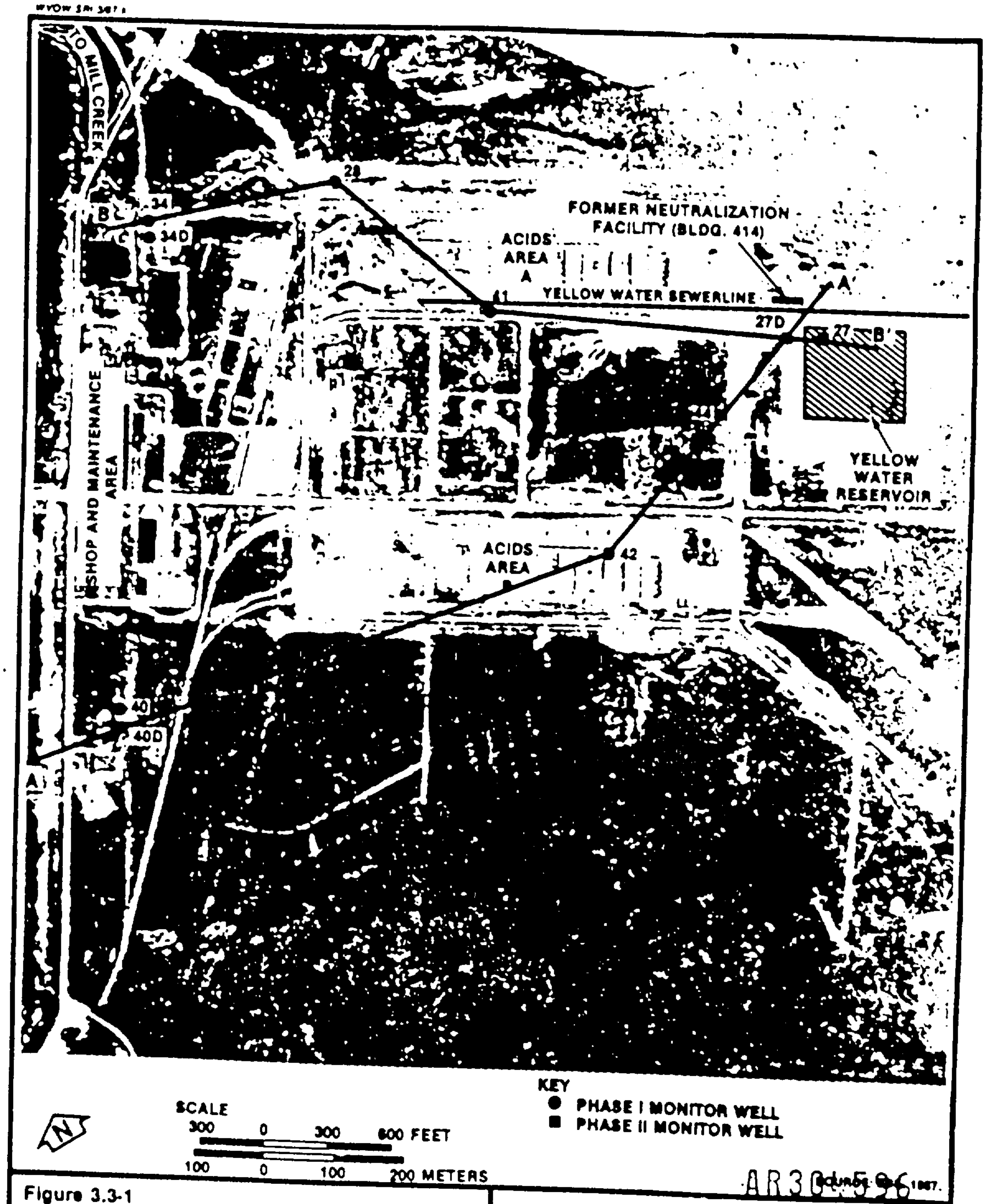

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Figure 3.3-1
GEOLOGIC CROSS-SECTION LOCATIONS IN THE ACIDS AREA/YELLOW WATER RESERVOIR

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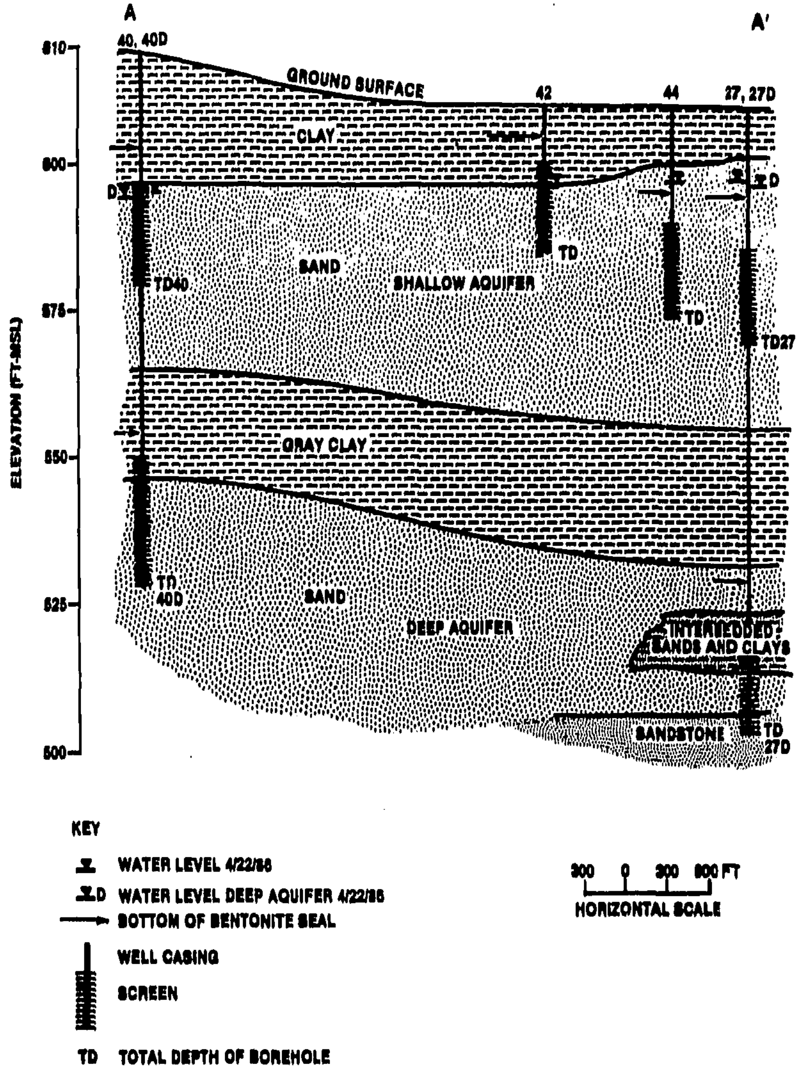

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Figure 3.3-2
GEOLOGIC CROSS-SECTION A - A',
ACIDS AREA/YELLOW WATER RESERVOIR

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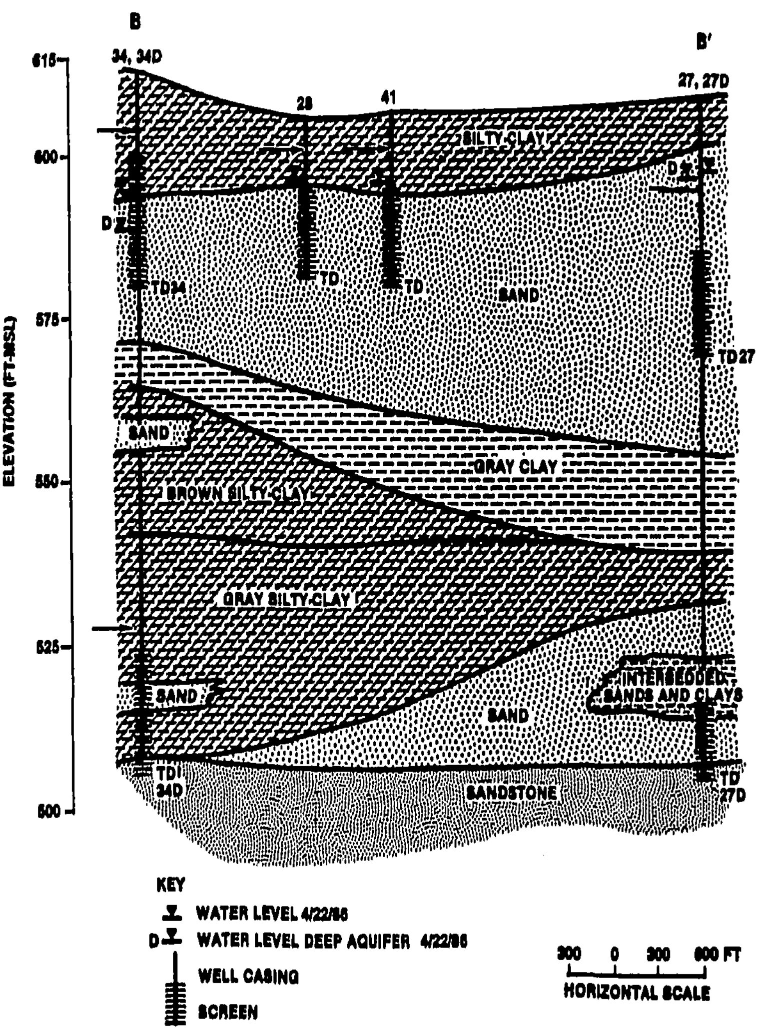

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SOURCE: ESE, 1987.

Figure 3.3-3 **GEOLOGIC CROSS-SECTION B - B',** **ACIDS AREA/YELLOW WATER RESERVOIR**	**WEST VIRGINIA** **ORDNANCE WORKS** Supplemental Remedial Investigation Phase II Field Program

GW44 is completed in the shallow aquifer. The physical characteristics of the shallow aquifer at GW44 were similar to those encountered at the remaining shallow monitor wells. These shallow sand aquifers are uniform in texture and gradation throughout this area and represent a continuous unconfined, or possibly semiconfined, aquifer.

Below the shallow sand aquifer at GW27D, a stiff gray clay, similar in textural and physical characteristics to the gray clay confining layer seen elsewhere at WVOW, was encountered at elevation 556 ft-MSL. The gray clay extends to elevation 533 ft-MSL, consistent with the thickness observed at the nearby powerhouses in Wells GW34D and GW40D. From elevations 533 to 507 ft-MSL, a deep aquifer primarily of sand with occasional interbedded clay lenses was encountered. At depth, this aquifer consists of typical glacial outwash sediments. At elevations 507 to 506 ft-MSL, bedrock was encountered, consisting of sandstone. The bottom of Well GW27D was situated at 506 ft-MSL.

Ground water level data collected during both phases of the RI survey for monitor wells in the Acids Area/Yellow Water Reservoir are presented in Table 3.2-2. During the Phase II investigation, water levels were measured on Apr. 22, 1986, and Aug. 11, 1986. For the purpose of this discussion, ground water levels measured on Apr. 22, 1986, will be employed for ground water movement calculations. Fig. 3.3-4 and Fig. 3.3-5 represent 2-dimensional plots showing ground water contours measured on Apr. 22, 1986, and Aug. 11, 1986, respectively. The data indicate that ground water flow is primarily to the west in the Acids Area/Yellow Water Reservoir, consistent with conditions observed in the Phase I investigation.

The approximate horizontal ground water flow rate can be calculated using the data and the aquifer values in the Phase I studies by employing the ground water flow equation:

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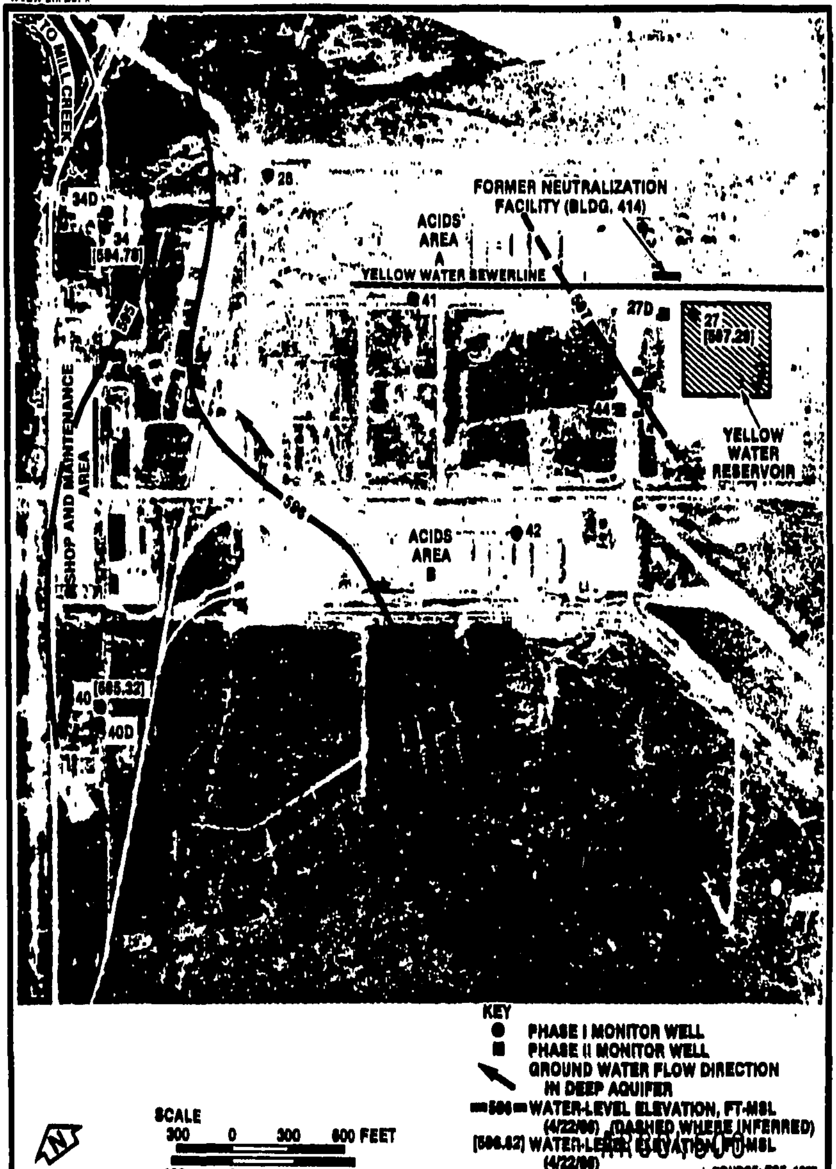

Figure 3.3-4
WATER-LEVEL CONTOURS, SHALLOW AQUIFER, ACIDS AREA/YELLOW WATER RESERVOIR — APRIL 22, 1986

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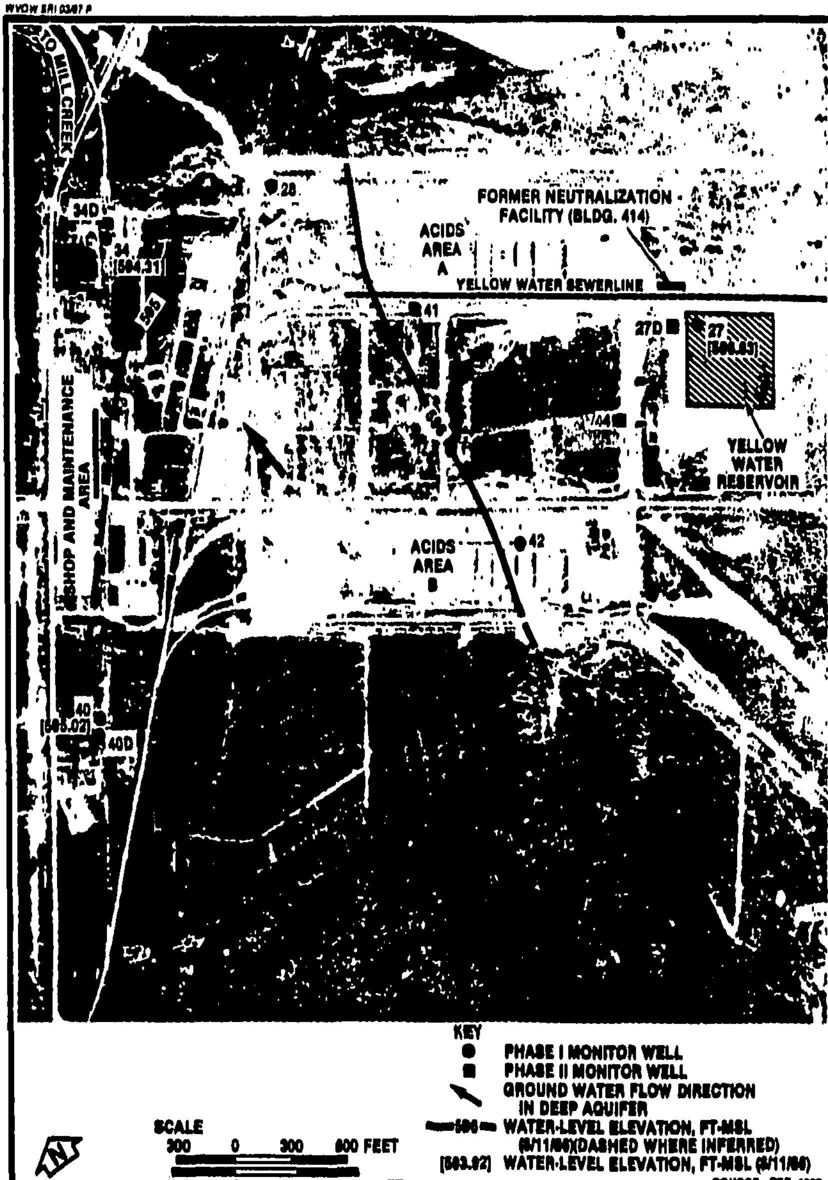

Figure 3.3-5
WATER-LEVEL CONTOURS, SHALLOW AQUIFER, ACIDS AREA/YELLOW WATER RESERVOIR — AUGUST 11, 1986

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$$V = \frac{K}{n} \times i$$

where: V = ground water flow rate (ft/sec),
K = hydraulic conductivity (ft/sec),
n = effective porosity (dimensionless), and
i = hydraulic gradient in feet per foot (ft/ft).

$$= \frac{5 \times 10^{-4} \text{ ft/sec}}{0.25} \; (5.8 \times 10^{-4} \text{ ft/ft})$$

$$= 1.2 \times 10^{-6} \text{ ft/sec}$$

$$= 0.1 \text{ foot per day (ft/day)}$$

The water levels measured on Apr. 22, 1986, correspond to a hydraulic gradient (i) of 1 ft/1,740 ft for 5.8×10^{-4} ft/ft. Ground water velocity is calculated at 0.1 ft/day, which is the same rate of horizontal ground water flow observed in the Phase I study.

A vertical gradient for the Acids Area/Yellow Water Reservoir can be estimated by utilizing the head relationship observed at the well pair GW27 and GW27D. In this case, the hydraulic gradient employed is taken as the head difference of the well pair divided by the distance between the midpoints of the respective saturated filter packs. The water levels observed on Apr. 22, 1986, were used in this calculation. The water level observed in GW27 on Apr. 22, 1986, was 0.67 ft higher than that observed in Well GW27D. The corresponding downward vertical gradient, therefore, is 0.67 ft/63.74 ft, or approximately 0.01. Vertical permeability through the gray clay layer was not directly calculated; it should be noted that the stratigraphic interval between these two aquifers consists of the gray clay confining layer which is 21 ft thick and would be expected to have a very low K value. If a value of 1×10^{-7} ft/sec and an effective porosity value of 0.50 are assumed for the clay, vertical flow rate would be calculated as follows:

$$V = \frac{K}{n} \times i$$

$$= \frac{1 \times 10^{-7}\ \text{ft/sec}}{0.50}\ (0.01\ \text{ft/ft})$$

$$= 2.0 \times 10^{-9}\ \text{ft/sec}$$

$$= 1.7 \times 10^{-4}\ \text{ft/day}$$

It can be concluded that a minimal vertical flow potential exists in the Acids Area/Yellow Water Reservoir. Furthermore, given the physical characteristics of the gray clay and its apparent continuity throughout the site, it is concluded that the clay acts as an effective barrier for vertical migration and should preclude any contamination of the shallow aquifer from migrating to the deep aquifer.

Horizontal ground water flow in the deep aquifer in the vicinity of the Acids Area/Yellow Water Reservoir has been determined using the water levels measured on Apr. 22, 1986, at Wells GW27D, GW34D, and GW40D. Since the ground water flow direction has been determined by analysis of water levels at only three observation points, a ground water contour map has not been prepared. The direction of ground water flow based on this analysis is north-northwest; the flow direction is indicated by the arrow shown in Fig. 3.3-4.

The approximate horizontal ground water flow rate in the deep aquifer can be calculated using the water levels of Apr. 22, 1986, coupled with aquifer values from the Phase I investigation. Since the three water-level measurements essentially define a plane, an estimated gradient was established based on the water-level elevations. The ground water flow equation would be applied as follows:

AR304603

$$V = \frac{K}{n} \times i$$

$$= \frac{4.6 \times 10^{-6} \text{ ft/sec}}{0.25} \; (3.8 \times 10^{-3} \text{ ft/ft})$$

$$= 7.0 \times 10^{-8} \text{ ft/sec}$$

$$= 6.0 \times 10^{-3} \text{ ft/day}$$

3.4 RED WATER RESERVOIRS

3.4.1 REVIEW OF PHASE I RI RESULTS

In the Phase I survey, the geologic setting of the Red Water Reservoirs area was defined using lithologic information obtained from three wells located adjacent to the reservoirs (GW29, GW30, and GW31), a well pair located south-southwest of the reservoirs along Mill Creek (GW32 and GW32D), and one well located west of the reservoirs where Mill Creek crosses SR 62 (GW33). A shallow aquifer is present at the Red Water Reservoirs consisting of a medium to coarse sand, which is overlain by silty clay surficial sediments. At GW30, GW31, and GW32D, the shallow aquifer was underlain by the gray clay confining layer. The thickness of the clay was 13 ft at GW32D.

The Phase I survey established the general hydrogeologic setting in the vicinity of the Red Water Reservoirs. General direction and rate of horizontal ground water flow in the shallow aquifer were determined. However, the Phase I monitor well network was installed on the assumption that shallow ground water flow was to the southwest toward Mill Creek. Ground water flow defined in the Phase I survey indicated that shallow ground water flow direction was to the northwest toward SR 62 and the Ohio River. Given this direction of ground water flow, no shallow monitor wells were present downgradient of the reservoirs. Ground water flow rate and direction were defined only for the immediate vicinity of the reservoirs, since no monitor wells were located at a substantial distance downgradient (northwest). In addition, no deep monitor wells were installed at the Red Water Reservoirs to define the vertical hydraulic head relationships or to verify the presence and thickness of the gray clay confining layer.

3.4.2 PHASE II RESULTS

To address the data gaps at the Red Water Reservoirs, a comprehensive Phase II hydrogeologic program was implemented in this study area. Three shallow monitor wells (GW45, GW46, and GW47) were installed downgradient of the Red Water Reservoirs (see Fig. 3.2-2). To determine shallow aquifer water quality and to provide water-level data, GW46 and GW47 were installed at the McClintic Wildlife Station property boundary. In addition, a well pair (GW45, GW45D) was installed immediately downgradient and adjacent to the Red Water Reservoirs. Well GW45 was completed in the shallow sand aquifer to assess water quality immediately downgradient of the reservoirs and to determine water levels in order to refine ground water flow direction and rate. Well GW45D was installed adjacent to GW45 and was completed in the deep aquifer to monitor water quality in the potable aquifer, verify the presence and thickness of the gray clay layer, and determine the vertical hydraulic gradient.

In addition to monitor well installation, additional sediment samples were collected in Pond 1 and Pond 2. The purpose of the sediment samples was to supplement the vertical contaminant distribution obtained during the Phase I survey as well as to provide further information on the integrity of the clay liners in both ponds. The sediment data are discussed in Sec. 4.2 of this report.

The shallow monitor wells (GW45, GW46, and GW47) confirmed that the shallow sand aquifer present in the Phase I monitor wells extends downgradient of the reservoirs. At Well GW47, located approximately 500 ft downgradient of the Red Water Reservoirs, the gray clay confining layer was encountered in the last 0.5 ft drilled. The gray clay confining layer at GW45D was encountered at elevation 556 ft-MSL. The gray clay layer extended to an elevation of 533 ft-MSL, a thickness of 23 ft at the Red Water Reservoirs. Below the gray clay layer, sand and gravel sediments extended to the total depth of the borehole (507 ft-MSL). The lower aquifer present in this vicinity consists of glacial outwash materials consistent in appearance with the glacial outwash observed at several other deep monitor wells at WVOW.

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Fig. 3.4-1 shows the locations of the geologic cross sections in the Red Water Reservoirs area, and Figs. 3.4-2 and 3.4-3 consist of general geologic cross sections of the Red Water Reservoirs area. As shown on the geologic cross section index map for the Red Water Reservoirs (Fig. 3.4-1), cross section C-C' extends north to south through the Red Water Reservoirs, and cross section D-D' extends northwest to southeast through the Red Water Reservoirs area.

Aquifer characteristics in the Red Water Reservoir area were defined in the Phase I field survey. The lithologic information obtained during drilling of the Phase II monitor wells indicated that the shallow aquifer present in Phase I monitor wells extends to the northwest and exhibits similar character. Therefore, the aquifer characteristics determined for the shallow aquifer in the Phase I survey were employed in the Phase II investigation.

Ground water level data collected during the Phase II RI are presented in Tables 3.2-2 and 3.2-3. Fig. 3.4-4 and Fig. 3.4-5 are 2-dimensional plots showing ground water contours measured on Apr. 22, 1986, and Aug. 14, 1986, respectively. As evident on the figures, ground water flow is primarily to the northwest. The flow patterns observed in the April 1986 and August 1986 measurements contrast markedly with the near-radial type flow pattern observed in the 1985 Phase I survey. To illustrate this difference, the Phase I water-level contours of Jan. 7, 1985, as plotted in the initial RI survey, are reproduced in Fig. 3.4-6.

It should be noted that the location of Well GW31 was plotted in error in the Phase I report (ESE, 1986d). The actual location of Well GW31 is correct as indicated on the Phase II results figures and on the revised Phase I figure.

The additional monitor wells installed during the Phase II survey have nearly doubled the data base available for interpretation of [illegible] flow direction and rate. Consequently, the water-level flow patterns

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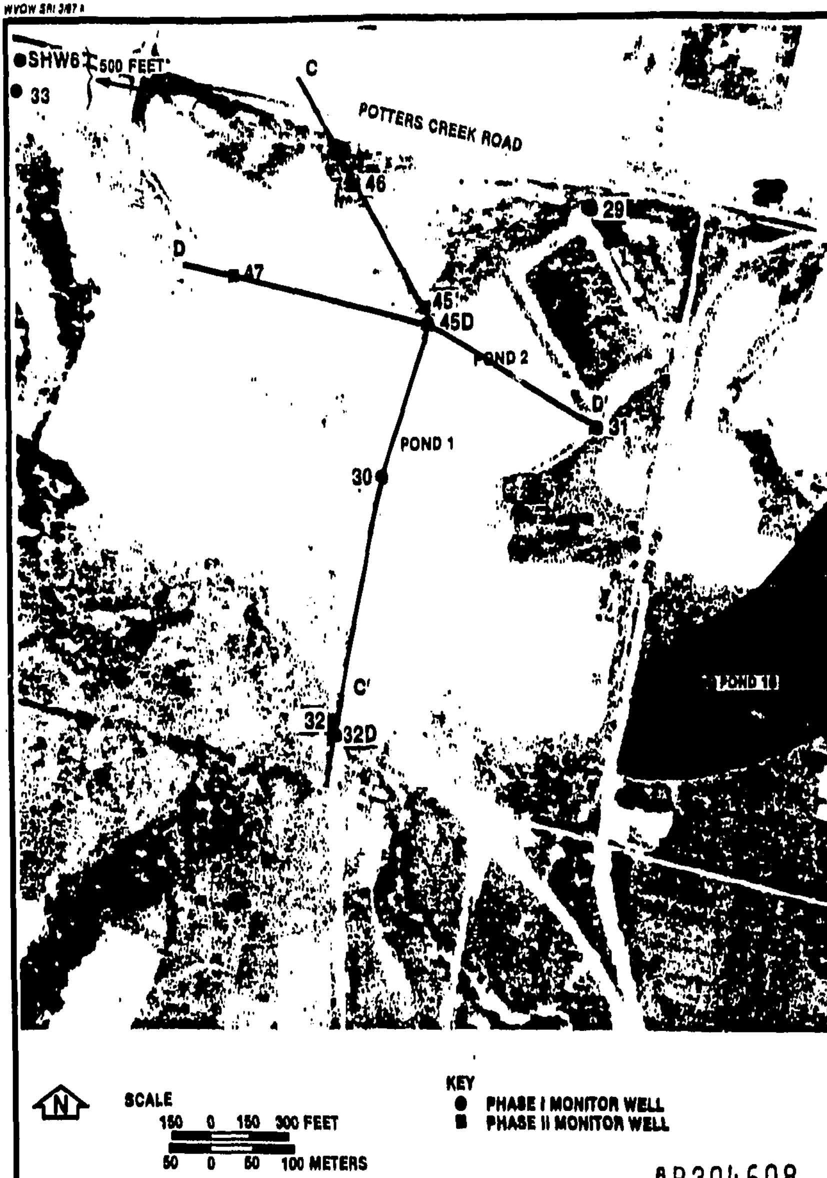

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Figure 3.4-1
GEOLOGIC CROSS-SECTION LOCATIONS IN THE RED WATER RESERVOIRS AREA

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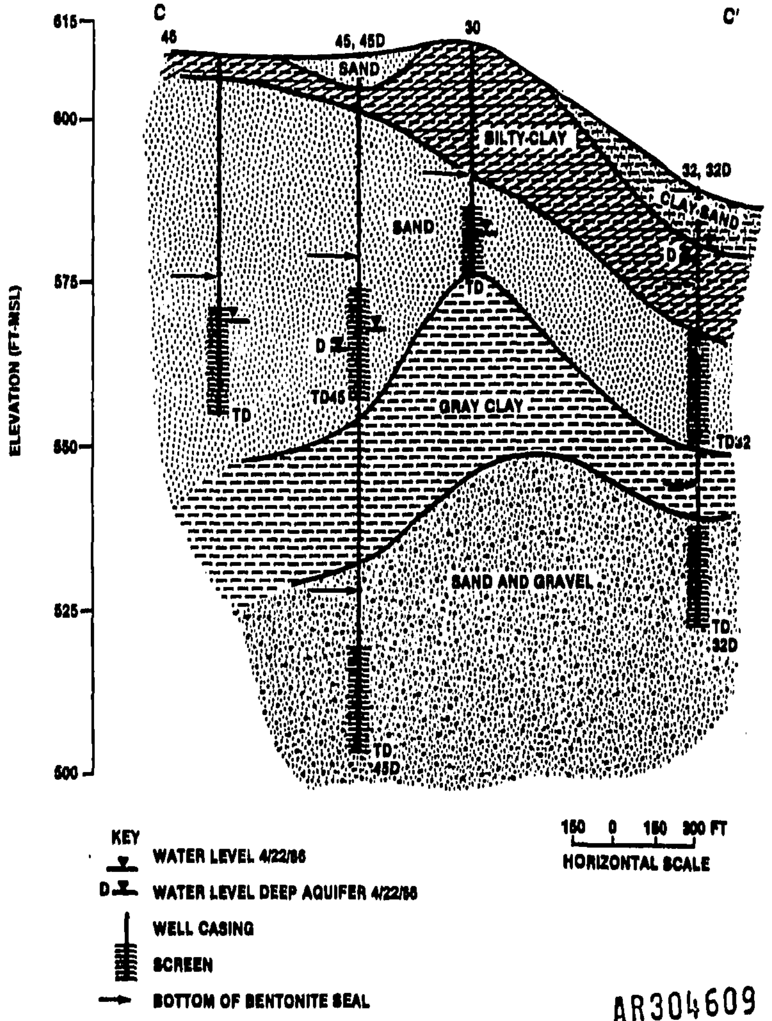

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Figure 3.4-2
GEOLOGIC CROSS-SECTION C - C', RED WATER RESERVOIRS

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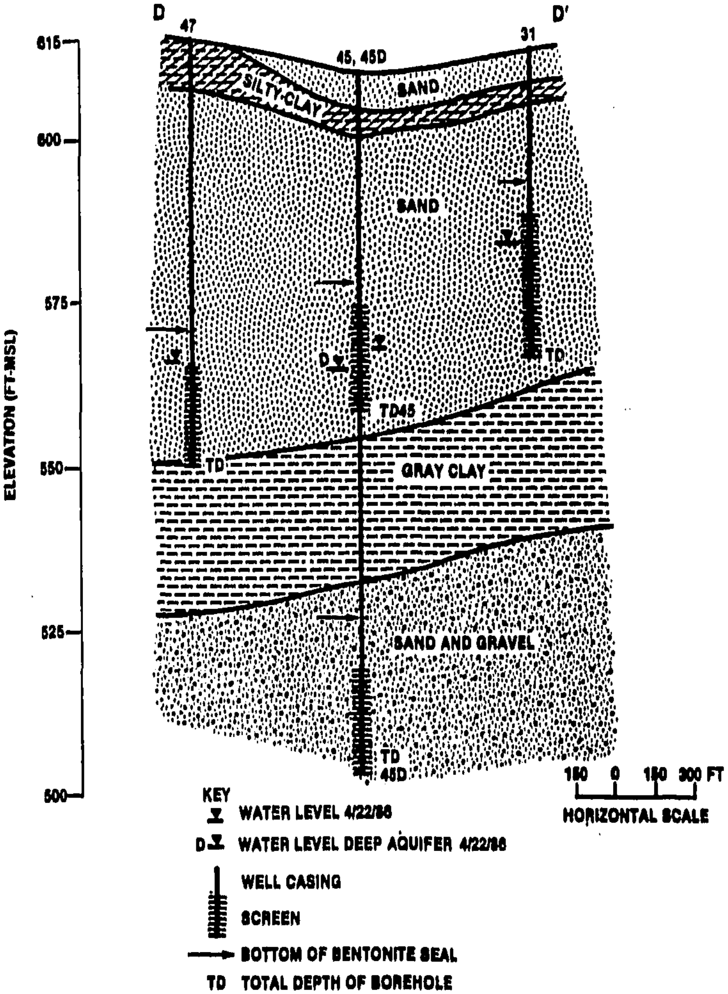

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SOURCE: ESE, 1987.

Figure 3.4-3 GEOLOGIC CROSS-SECTION D—D', RED WATER RESERVOIRS	WEST VIRGINIA ORDNANCE WORKS Supplemental Remedial Investigation Phase II Field Program

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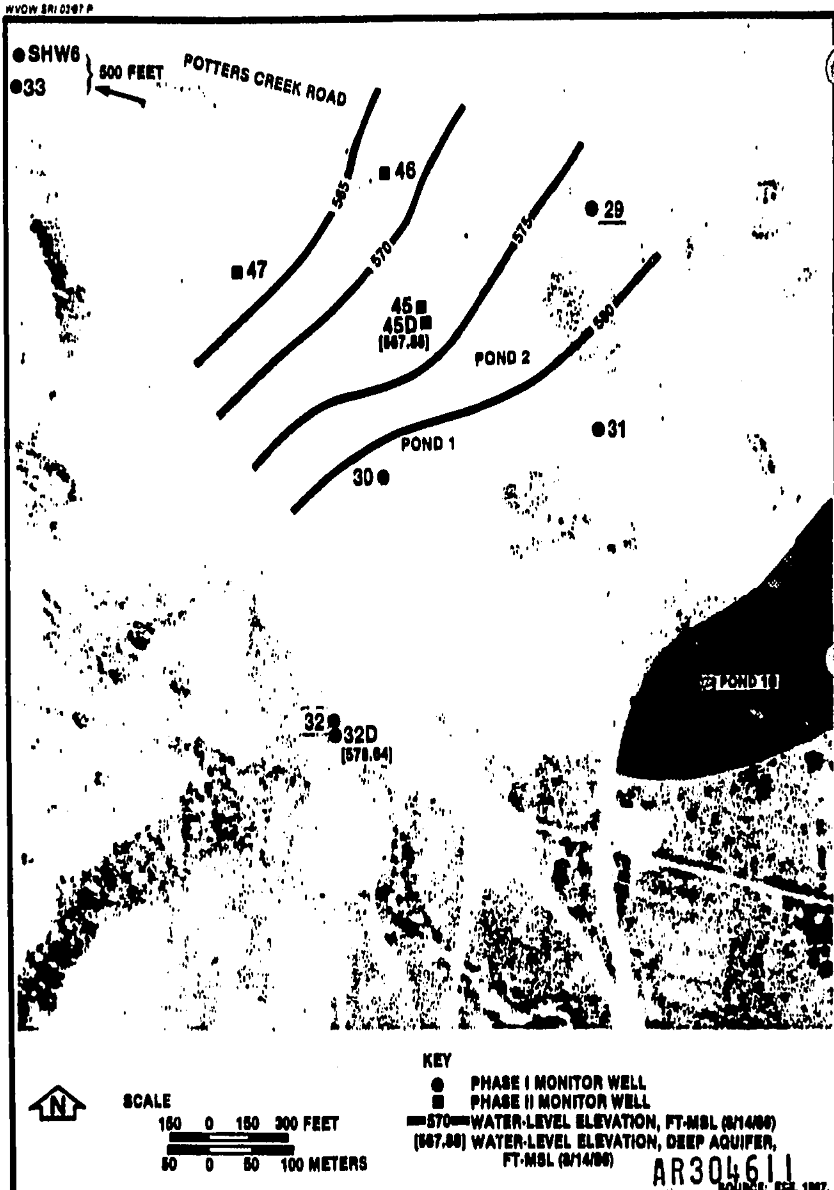

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Figure 3.4-4
WATER-LEVEL CONTOURS, SHALLOW AQUIFER, RED WATER RESERVOIRS — AUGUST 14, 1986

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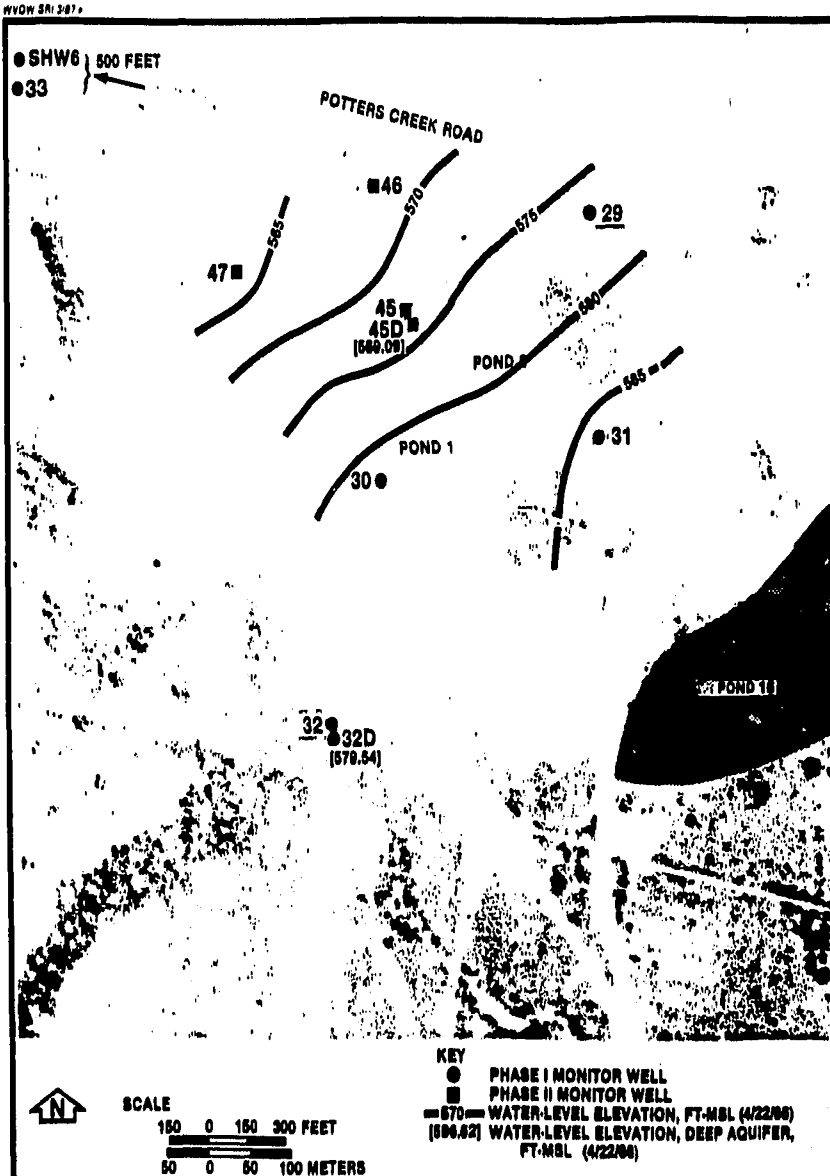

SOURCE: ESE, 1987.

Figure 3.4-5
WATER-LEVEL CONTOURS, SHALLOW AQUIFER, RED WATER RESERVOIRS — APRIL 22, 1986

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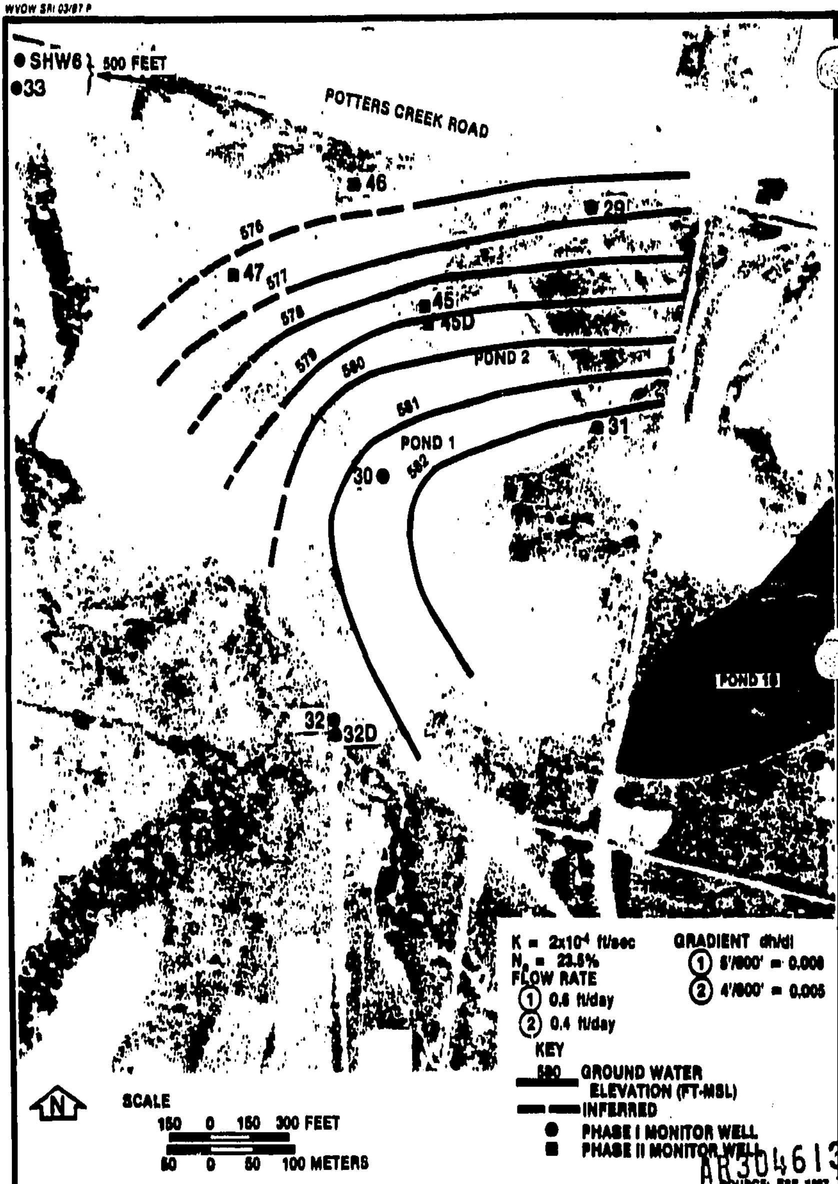

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Figure 3.4-6
WATER-LEVEL CONTOURS, RED WATER RESERVOIRS — JANUARY 7, 1985

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Phase II Field Program

observed in the Phase II survey represent a more accurate estimate of actual ground water flow patterns in the vicinity of the Red Water Reservoirs. The Phase I survey monitoring network lacked adequate downgradient monitor wells to provide a definitive flow pattern determination.

Ground water flow rate in the shallow aquifer can be determined by employing the water-level flow patterns of the Phase II survey in conjunction with the aquifer characteristic parameters determined in the Phase I survey. The hydraulic gradients observed in the April 1986 and August 1986 measurements were nearly identical; the hydraulic gradient determined is 0.02 ft/ft. Using the aquifer porosity and permeability values obtained in the Phase I survey, an estimate of ground water flow rate in this shallow aquifer is calculated as follows:

$$V = \frac{K}{n} \times i$$

$$= \frac{2.4 \times 10^{-4} \text{ ft/sec}}{0.24} \quad (0.02 \text{ ft/ft})$$

$$= 2 \times 10^{-5} \text{ ft/sec}$$

$$= 1.7 \text{ ft/day}$$

The defined shallow ground water flow rate measured using the 1986 data is approximately three times greater than that determined in the 1984-1985 Phase I survey (0.5 ft/day). There are several reasons for this apparent discrepancy between the two surveys. In the Phase I survey, the ground water flow gradient was determined using the difference in hydraulic head as measured between Wells GW31 and GW29. As stated previously, location for GW31 was plotted in error on the figures and was subsequently employed in the flow-rate calculations. AR304614 Additionally, the inadequate density of the monitor well network in the Phase I survey led to the incorrect assumption (as shown in Fig. 3.4-6) that Well GW29 was directly downgradient of Well GW31. As is evident in the figures depicting ground water flow patterns observed in 1986, Well GW29 is not directly downgradient of Well GW31 but is located midway between a downgradient and cross-gradient position. The difference in well location for GW-31, coupled with the position of GW29 in the flow field, accounts for this apparent discrepancy in hydraulic gradients calculated in the Phase I versus the Phase II surveys.

At the well pair, GW45 and GW45D, the potential of vertical downward migration can be assessed. The hydraulic gradient employed is taken as the head difference of the well pair divided by the distance between the midpoints of the respective saturated filter packs. In this well pair, the hydraulic head difference is relatively small--approximately 3 ft. The vertical gradient, therefore, is 3 ft/51 ft, or approximately 0.06. Although vertical permeability through the gray clay confining layer was not directly calculated, a very low permeability value would be expected for the gray clay. As used in previous calculations, a permeability value of 1×10^{-7} ft/sec and an effective porosity value of 0.50 were assumed for the gray clay. The vertical flow potential is calculated as follows:

$$V = \frac{K}{n} \times i$$

$$= \frac{1 \times 10^{-7} \text{ ft/sec}}{0.50} \ (0.06 \text{ ft/ft})$$

$$= 1.2 \times 10^{-8} \text{ ft/sec}$$

$$= 1 \times 10^{-3} \text{ ft/day}$$

The low vertical flow rate estimated at 1×10^{-3} ft/day coupled with the vertical extent of the gray clay layer at this well pair (23 ft) indicates that the downward vertical flow potential and contaminant migration from the shallow aquifer to the deep aquifer are minimal.

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With the addition of GW45D, two deep wells completed in the glacial outwash aquifers are present in the vicinity of the Red Water Reservoirs. Although a flow rate and accurate determination of ground water flow direction are not feasible, a general tendency of flow direction can be established.

The water level in GW32D is approximately 11 ft higher than that observed in GW45D. It can be concluded that ground water flow direction in the deep aquifer has a strong northerly component. These results are consistent with the ground water flow direction in the deep aquifer observed at the Acids Area/Yellow Water Reservoir. If it is assumed for purposes of discussion that the gradient observed between Wells GW32D and GW45D is directly along ground water flow lines, a rough approximation of ground water flow rate can be determined as follows:

$$V = \frac{K}{n} \times i$$

$$= \frac{2.5 \times 10^{-5} \text{ ft/sec}}{0.25 \text{ (assumed)}} \quad (0.03 \text{ ft/ft})$$

$$= 3 \times 10^{-6} \text{ ft/sec}$$

$$= 0.3 \text{ ft/day}$$

3.5 POND 13/WET WELL AREA

3.5.1 REVIEW OF PHASE I RI RESULTS

In the Phase I RI survey, the geologic setting of the Pond 13/Wet Well Area was defined using lithologic information obtained from two well pairs installed by ESE and from four shallow monitor wells installed in 1982 by an EPA contractor. The data from these monitor wells indicated that two markedly different hydrogeologic environments were present in the area surrounding Pond 13 (Fig. 3.5-1). At Pond 13, near-surface sediments consist of a thin (5- to 10-ft) layer of sandy, silty clay underlain by a permeable, water-bearing shallow aquifer. At Well GW23I, this shallow aquifer is underlain by a thin, probably discontinuous, clay layer. A second, interconnected sand layer occurs; below the second sand, a gray clay confining layer is present. Because the borehole extended only a short distance into the clay before it was terminated, the thickness of the gray clay layer could not be determined. To the southeast, Wells GW22 and GW22D were completed in a markedly different geologic environment. At this location, clay extends from the ground surface to a depth of approximately 60 ft. The gray clay layer is present beginning at 560 ft-MSL and extends 25 ft in thickness. At the well pair GW22 and GW22D, the shallow aquifer present at Pond 13 is absent. The only water-bearing aquifer at this location is the glacial outwash which extends from approximately 70 to 105 ft in depth and terminates at the top of bedrock which was encountered in Well GW22D.

Water levels measured during the Phase I survey indicated a possible ground water flow direction to the north, opposite the observed surface water flow direction in the area. With the absence of additional data points to the north of Pond 13, it was not possible to verify the actual ground water flow patterns in this area. It was believed that the hydraulic gradients indicated in the Phase I study were not indicative of a substantial hydraulic gradient to the north.

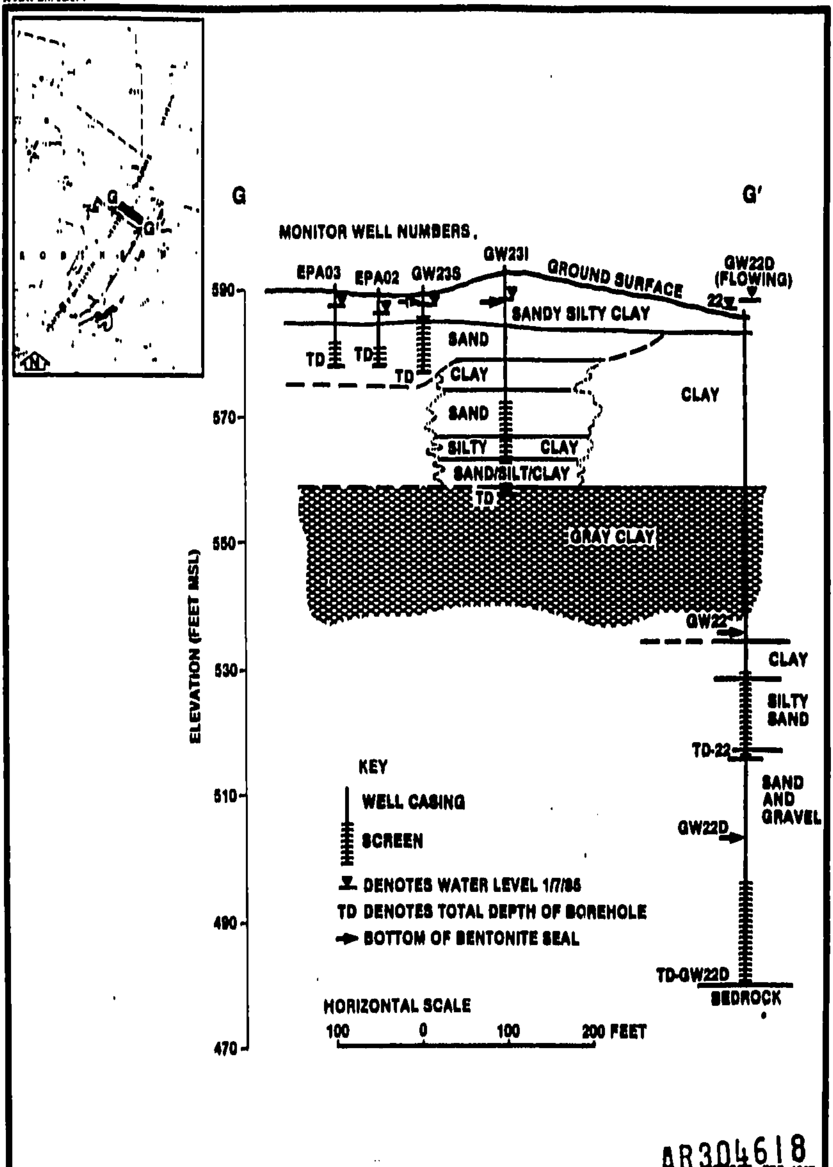

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Figure 3.5-1
WEST-TO-EAST GEOLOGIC CROSS SECTION IN THE POND 13 AREA

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Two distinct hydrogeologic settings were evident in the vicinity of Pond 13. However, neither the areal extent of the shallow sand aquifer at the Pond 13 seep area nor the areal extent of the setting observed at GW22 and GW22D could be determined.

In addition, the water-level elevations observed at EPA02 were several feet lower than adjacent wells completed in the same aquifer. This apparent discrepancy was attributed to a surveying error.

3.5.2 PHASE II RESULTS

To address the data gaps from the Phase I field survey, the Phase II program consisted of shallow and deep monitor well installation and a resurvey of EPA02.

Monitor well locations for the Phase II survey are shown in Fig. 3.5-2. Both shallow and deep monitor wells were installed in the vicinity of Pond 13 to provide additional areal coverage to refine the shallow ground water flow patterns and to document the thickness of the gray clay layer. In addition, a water-level observation well (OW32S) was installed northwest of Wet Well No. 1 and EPA04 to provide additional areal coverage of ground water flow patterns. At location GW48D, a planned well pair, the shallow well GW48 was not drilled when conditions consistent with those observed at GW22 and GW22D were encountered (i.e., the shallow aquifer was not present and only the deep glacial outwash aquifer existed at this location). Well GW49 is a shallow aquifer monitor well located north of Pond 12, between Pond 13 and Pond 12. Based on the information obtained during the Phase II drilling program, a generalized geologic cross section has been prepared of the Pond 13/Wet Well Area. As shown on the geologic cross-section index map (see Fig. 3.2-3), cross section E-E' extends approximately north to south through the Pond 13/Wet Well Area.

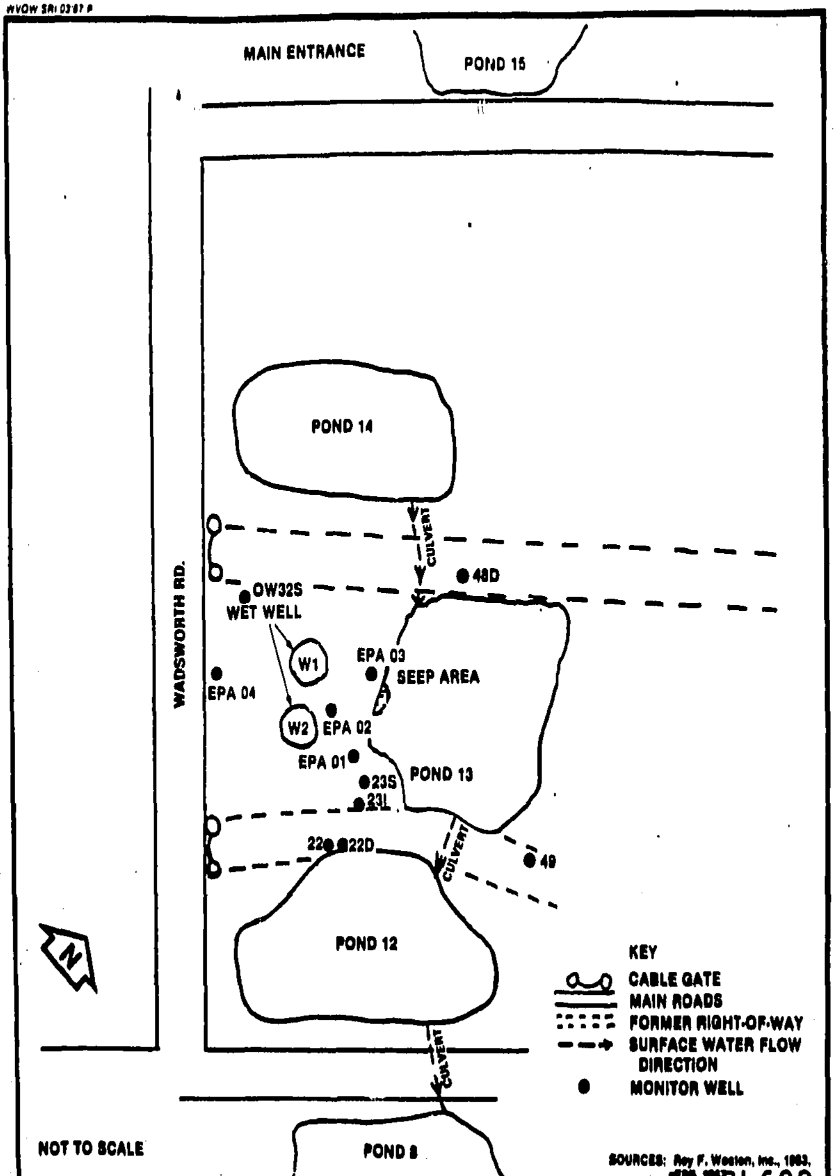

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Figure 3.5-2
LOCATIONS OF GROUND WATER MONITOR AND OBSERVATION WELLS IN THE POND 13/WET WELL AREA

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Phase II Field Program

As shown on the cross section (Fig. 3.5-3), the additional monitor wells drilled in the Phase II program have served to verify the areal extent of the two distinct hydrogeologic environments present at Pond 13. The shallow aquifer encompassing the seep area is depicted as the sand unit on the figure below monitor well GW24. The shallow sand aquifer is underlain by the gray clay layer in the area surrounding Pond 13. The gray clay layer, as is evident throughout the rest of WVOW, is continuous at Pond 13 and is approximately 30 to 40 ft thick.

The ground water level measurements collected during the Phase II RI survey are presented in Tables 3.2-2 and 3.2-3. For the purposes of this discussion, ground water levels measured during the Apr. 22, 1986 sampling episode will be employed. During the resurvey of Well EPA02, it was determined that a surveying error had occurred in the Phase I program, and the corrected elevation is employed in this study.

In the Phase I investigation, a confident estimate of ground water flow rate and direction was not possible. Water levels measured at the monitor wells at Pond 13 provided inconclusive data for ground water flow direction determination. The additional wells installed during the Phase II program provided a substantially greater data base to determine the areal extent of the aquifers present and the flow direction. All available data indicate that the shallow aquifer is of limited extent, and, based on the water-level measurements, essentially no direction of ground water flow can be established for the shallow sand aquifer. As indicated by the water-level elevations plotted in Fig. 3.5-4, ground water elevations at Wells EPA01 through EPA04 and at Wells GW23S and GW23I are essentially the same.

The shallow aquifer terminates to the north, as evidenced by the substantial clay thicknesses observed at Well GW48D. At GW49, a shallow well to the east of Pond 13, water levels are approximately 0.8 ft higher than at the Pond 13 Area, indicating that ground water flow is not in this direction.

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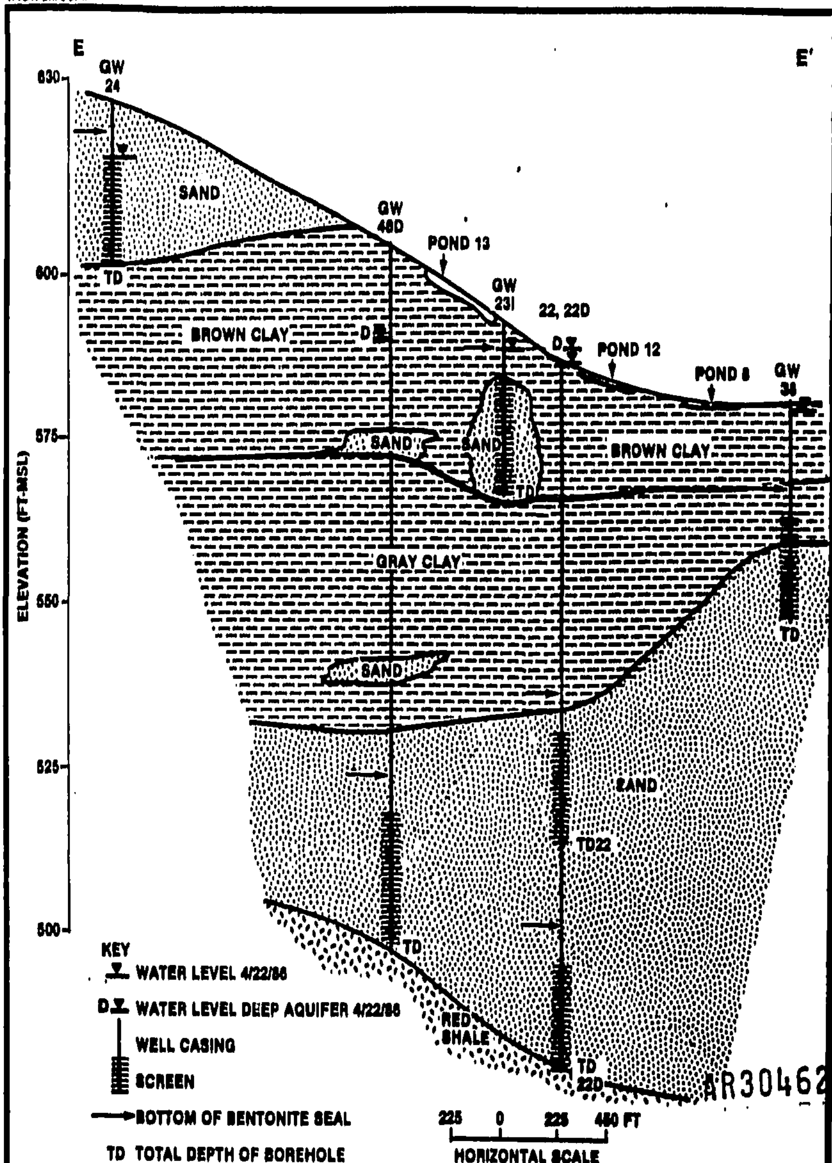

SOURCE: ESE, 1987.

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Figure 3.5-3 GEOLOGIC CROSS SECTION E - E', POND 13/WET WELL AREA	WEST VIRGINIA ORDNANCE WORKS Supplemental Remedial Investigation Phase II Field Program

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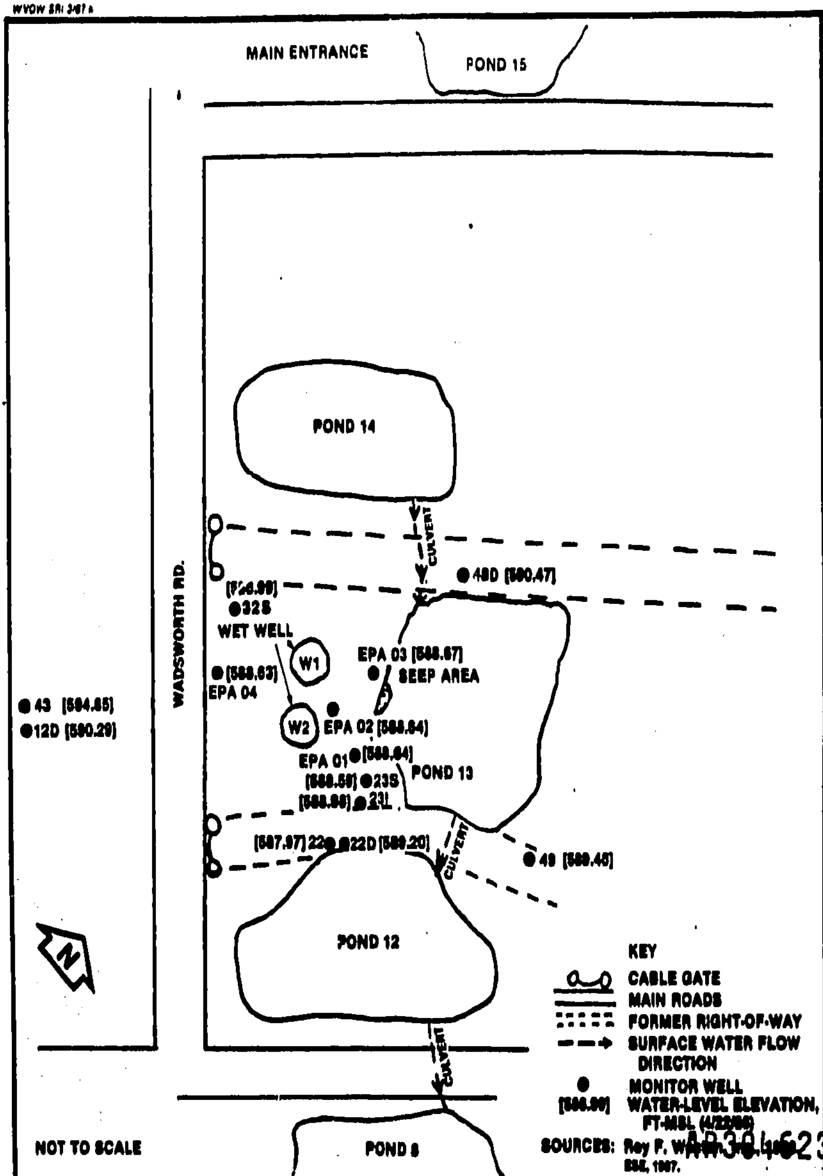

Figure 3.5-4
GROUND WATER LEVELS, POND 13/
WET WELL AREA — APRIL 22, 1986

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Phase II Field Program

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The shallow aquifer is not present at Wells GW48D and GW22/GW22D. The shallow aquifer at Pond 13 is bounded by vertically and areally extensive clay deposits to the north and to the south. The gray clay confining layer has been determined to be present at Pond 13 and is of sufficient thickness to preclude vertical contaminant migration. Furthermore, it should be noted that the hydraulic head values for the deep-aquifer monitor wells GW22D and GW48D are higher than those observed at the shallow sand aquifer monitor wells at Pond 13. Essentially, a minor upward gradient is present between the shallow aquifer and the deep glacial outwash aquifer. This further substantiates the conclusion that vertical downward migration in the contaminated shallow aquifer at the Pond 13/Wet Well Area is not possible.

3.6 SURFACE WATER ELEVATIONS

The initial RI survey (ESE, 1986d) at WVOW contained a comprehensive surface water program including stream gaging, flow measurements, and pond gaging. The program analyzed surface water processes in the Mill Creek and Oldtown Creek drainage basins and most ponds at the McClintic Wildlife Station. The physical hydrologic characteristics of the site, as addressed in the contamination assessment, determined that surface water contaminant migration was not a major exposure pathway at WVOW.

The Phase II program consisted of one round of surface water level measurements at all stream and pond gaging stations. The water level measurements collected in the Phase II field program are shown in Table 3.6-1. The locations of surface water gaging stations are shown in Fig. 3.6-1. The Phase II water levels were consistent with the 1984-1985 data obtained in the initial RI survey (ESE, 1986d). Representative surface water levels for the three areas of concern as assessed in the Phase I Survey are discussed in Sec. 3.1.

Table 3.6-1. Surface Water Elevations--April 22, 1986

Sampling Station	Water-Level Elevation (ft-MSL)
Pond Gages	
P1	602.40
P2	601.01
P3	614.07
P6	579.49
P8	580.26
P9	579.61
P10	--
P13	588.88
P14	593.56
P15	610.75
P16	--
P17	--
P18	575.90
P19	--
P24	620.46
P28	591.93
P29	588.12
P30	586.06
P31	585.32
P32	--
P33	578.73
Mill Creek Stations	
MC1	566.01
MC2	582.31
MC4	585.26
MC5	596.41
MC8	607.99
Oldtown Creek Stations	
OTC1	555.27
OTC3	559.74
OTC4	559.05
OTC5	582.74
OTC6	558.25

-- = Staff gage missing.

Source: ESE, 1986a.

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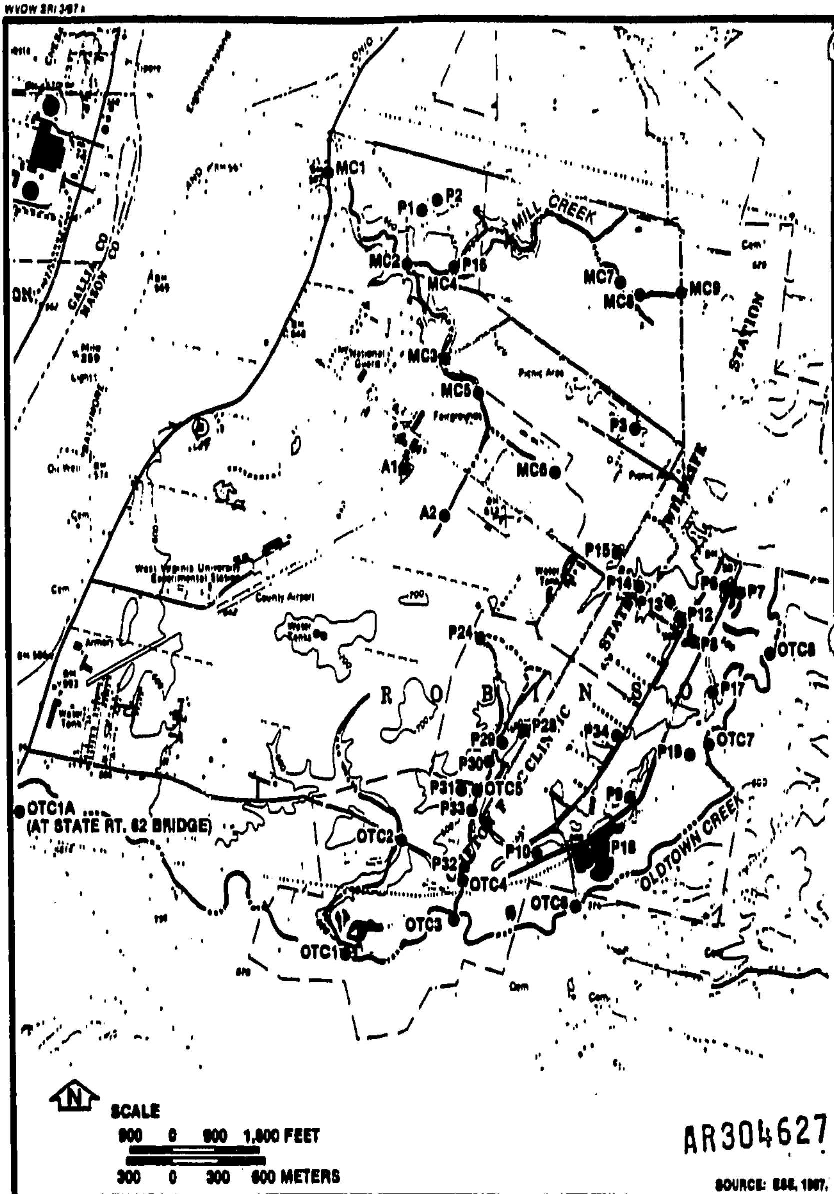

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Figure 3.6-1
LOCATIONS OF SURFACE WATER GAGING STATIONS

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Phase II Field Program

3.7 SITEWIDE HYDROGEOLOGY--PHASE II RESULTS

The supplemental RI survey has provided valuable information regarding the areal and vertical extent of the aquifer systems present at WVOW. At most areas of concern, a 2-aquifer system is present in the unconsolidated sediments. At the Acids Area/Yellow Water Reservoir and the Red Water Reservoirs, a shallow alluvial aquifer is separated from the deep glacial outwash aquifer by the gray clay confining layer. The glacial outwash aquifer is present at all site areas of concern at similar physical characteristics. According to published information (Wilmoth, 1966), the glacial outwash aquifer represents a single, continuous, aquifer system. The data obtained in the WVOW field investigations appear to confirm this statement.

The gray clay confining layer which separates the alluvial aquifer from the deep glacial outwash aquifer is present in all areas of concern at WVOW. The clay has been detected in 23 boreholes in the field investigations. Of the 23 boreholes, 21 penetrated the entire thickness of the clay unit, allowing quantification of the sitewide variations in thickness of the clay. The clay ranges in thickness from 5 to 42 ft across the site. The average (mean) thickness is 18.3 ft; the median thickness is 14 ft. The data indicate that the gray clay persists throughout WVOW and acts as an effective barrier to vertical contaminant migration. The clay was typically uniform in color (dark gray), lithology, and consistency. The extent, composition, and thickness indicate that the clay provides an effective barrier to potential vertical contaminant migration. The extent and characteristics of the gray clay are listed in Table 3.7-1. Fig. 3.7-1 and Fig. 3.7-2 show the thickness of the gray clay and the elevation of the top of the unit across the site, respectively.

Water levels measured in the shallow alluvial aquifer and the deep glacial outwash aquifer on Apr. 22, 1986, were used to prepare sitewide water-level contours. Fig. 3.7-3 and Fig. 3.7-4 are 2-dimensional plots

Table 3.7-1. Gray Clay Confining Layer--Extent and Characteristics

Well Designation	Top-of-Clay Elevation (ft-MSL)	Thickness (ft)
GW01	571	9
GW04	575	8
GW05	555	17
GW06	562	8
GW07	557	13
GW09	551	21
GW10	574	36
GW12	569	33
GW21	561	37
GW22	560	25
GW27	556	23
GW30	578	5
GW32	551	13
GW34	562	6
GW35	565	14
GW36	561	19
GW38	570	9
GW39	566	10
GW40	560	13
GW45	556	23
GW48	573	42

Source: ESE, 1986a.

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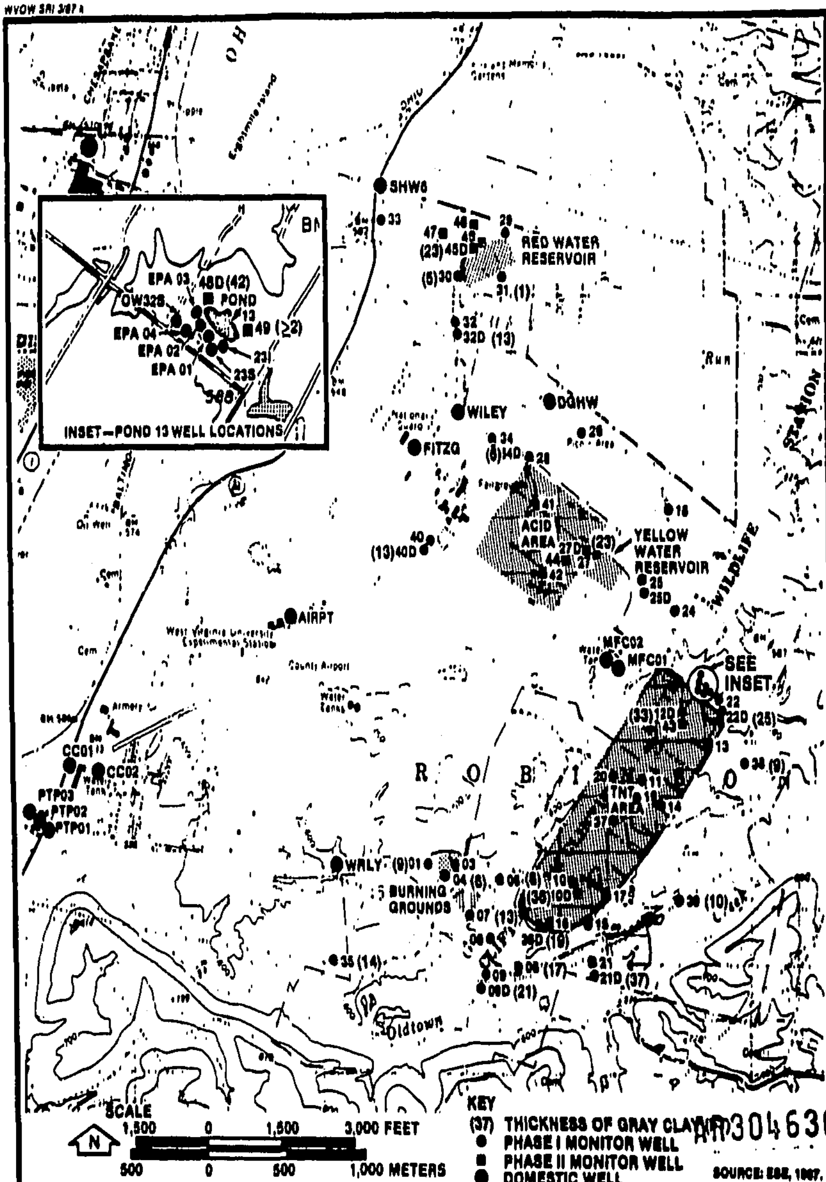

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Figure 3.7-1
THICKNESS OF GRAY CLAY CONFINING LAYER

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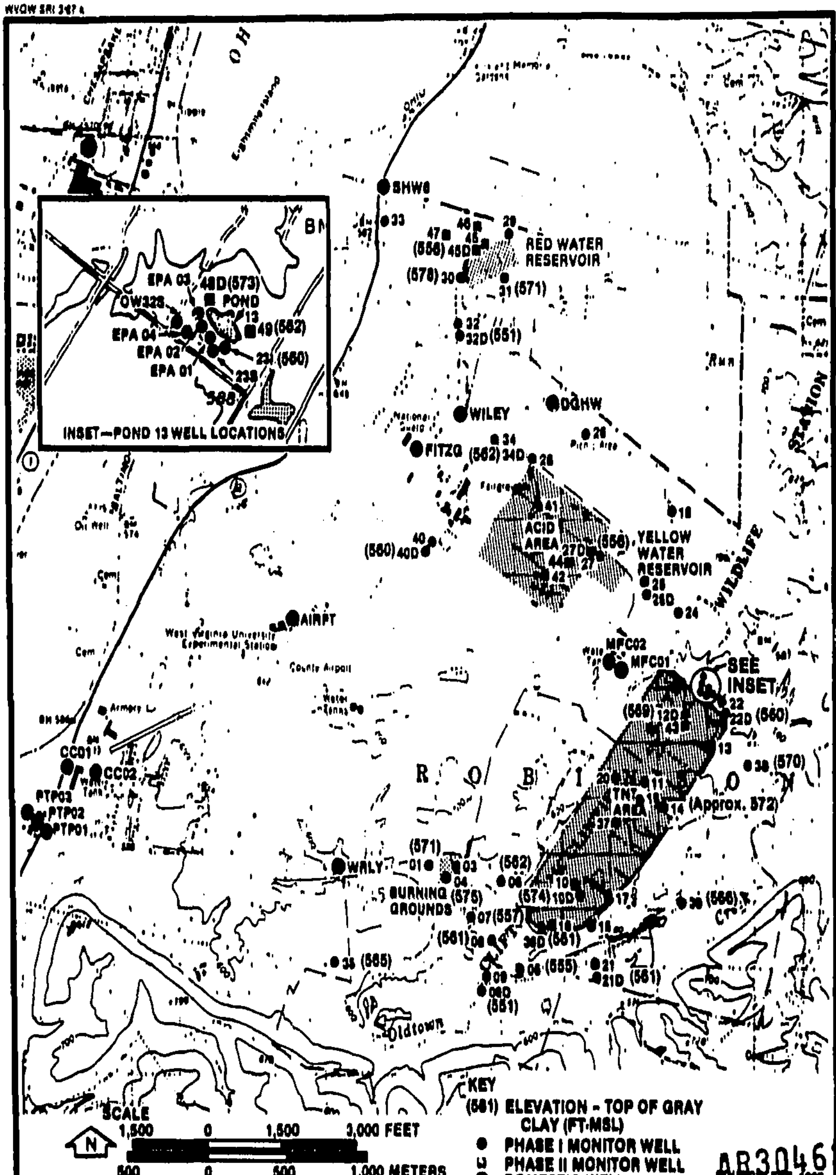

Figure 3.7-2
ELEVATION—TOP OF GRAY CLAY CONFINING LAYER

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Phase II Field Program

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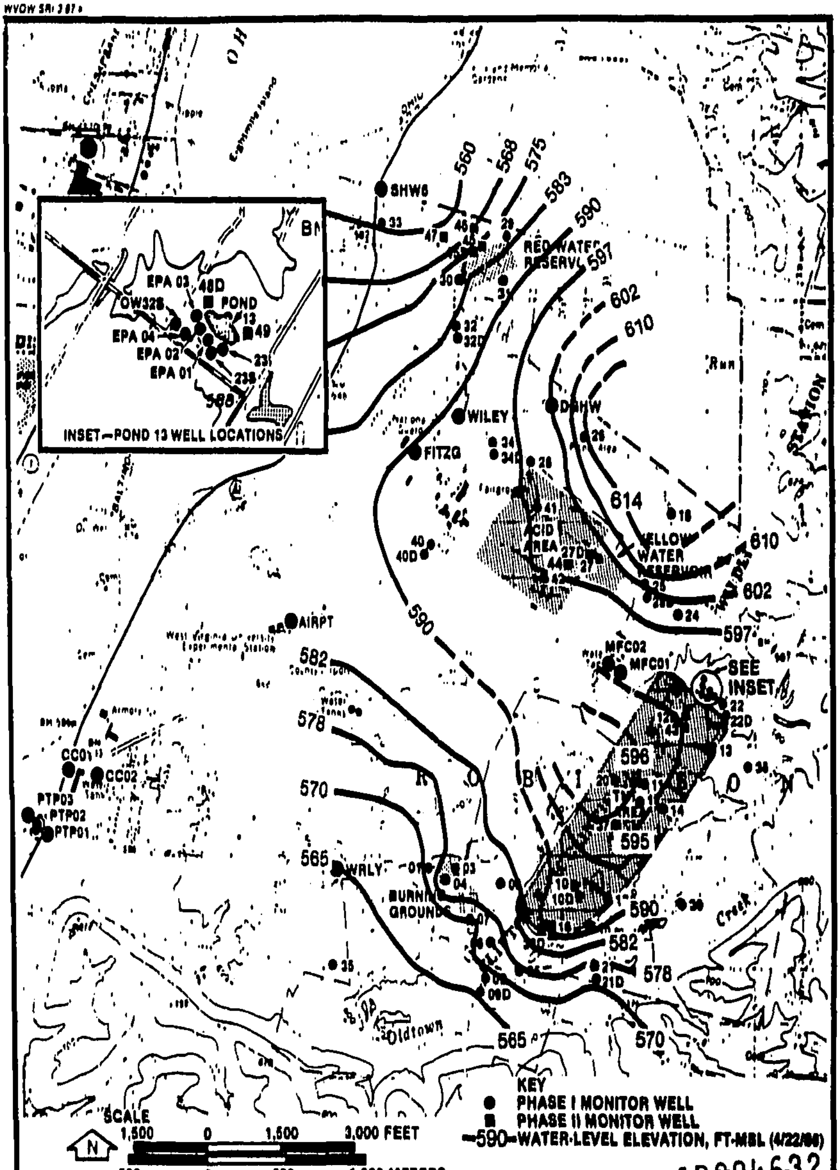

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Figure 3.7-3 SITEWIDE GROUND WATER LEVEL CONTOURS, SHALLOW AQUIFER — APRIL 22, 1986	WEST VIRGINIA ORDNANCE WORKS Supplemental Remedial Investigation Phase II Field Program

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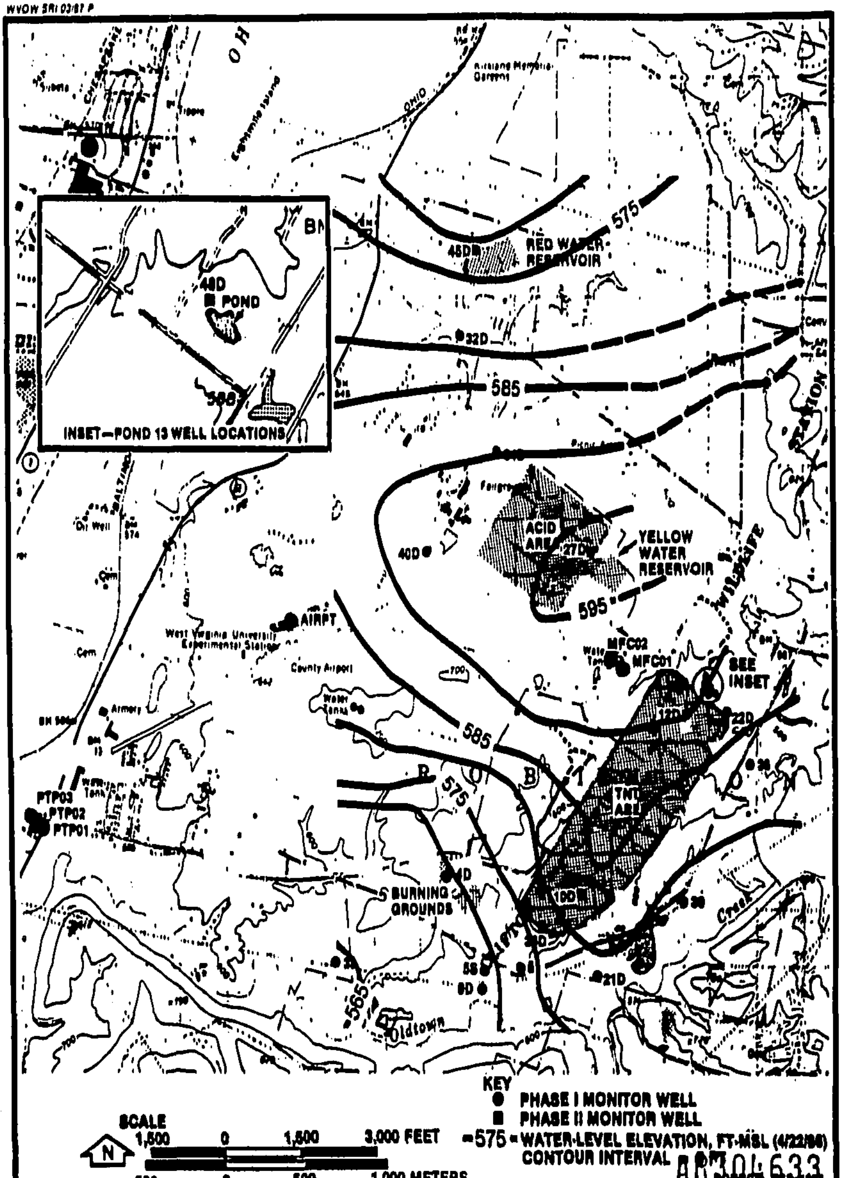

Figure 3.7-4
SITEWIDE POTENTIOMETRIC CONTOURS,
DEEP AQUIFER — APRIL 22, 1986

WEST VIRGINIA ORDNANCE WORKS
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Phase II Field Program

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showing ground water contours in the shallow alluvial aquifer and deep glacial outwash aquifer, respectively. In the shallow aquifer, ground water flow is predominantly westward. At the Red Water Reservoirs, a northwest flow is evident, whereas a southwest flow is evident in the vicinity of the Burning Grounds Area. In the deep aquifer, a flow divide is apparent in the vicinity of the Acids Area/Yellow Water Reservoir. This divide extends approximately west to east; ground water flows to the north in the northern portion of the site, and flow is to the south and southwest in the southern portion of WVOW.

4.0 CONTAMINATION ASSESSMENT

4.1 PHASE II RESULTS

Phase II ground water and sediment samples were analyzed for nitroaromatics using USATHAMA Methods C2 and D2, respectively. According to USATHAMA protocol, C2 was classified as a semiquantitative method based on 1-day analyses of the standard matrix samples spiked at specific levels. Data resulting from a semiquantitative method are reported to one significant digit. Method D2 was classified as a quantitative method based on a 4-day analysis of the spiked samples. Data are presented to two significant digits. Certified detection limits, Quality Control (QC) spiking levels, and the certified range were derived from the standard matrix sample spike analyses. The QC spiking levels for Methods C2 and D2 were approximately 2.5 and 10 times the certified detection limit. Calibration standards, sample concentrations, and daily QC spikes should all be within the certified range of the compounds.

In the data review discussed in the folowing sections, the detection limits may vary from sample to sample and in certain instances are greater than the certified detection limit.

In cases where the concentration of an analyte was greater than the highest calibration standard, the sample was diluted in order to be within the certified range. Dilution of a multielement sample can raise the detection limit of a compound to a concentration greater than the detection limit by the appropriate dilution factor.

A second explanation for detection limit variance occurred during the April 1986 analyses of the EPA wells and GW33, GW41, and GW44. In this case, to compensate for low spike recoveries for 1,3,5-TNB and 2,4,6-TNT, the detection limits for these two compounds were raised. The detection limit for 1,3,5-TNB was raised from 2 to 10 μg/L, and for 2,4,6-TNT the limit changed from 0.08 to 2 μg/L. Appropriate dilution factors were then applied.

4.2 ACIDS AREA/YELLOW WATER RESERVOIR

4.2.1 REVIEW OF PHASE I RI RESULTS

As described in the Phase I RI report (ESE, 1986d), detectable levels of nitroaromatic compounds were observed during 1985 in the shallow aquifer at Monitor Well GW27 in the area of thu former Yellow Water Reservoir and in Well GW41, which was located along the route of the underground yellow water sewerline. The contamination of the shallow ground water apparently is related to the storage of yellow water in the former reservoir and leakage of yellow water from the sewerline. Soils underlying the Yellow Water Reservoir and soils along the bed of the yellow water sewerline were found to contain nitroaromatic compounds during the Phase I RI (ESE, 1986d).

4.2.2 PHASE II RESULTS

To better define the horizontal and vertical extent of ground water contamination, the Phase II investigation in this area included the installation and sampling of two additional monitor wells (GW27D and GW44) plus the resampling of the eight wells that were installed in the fall of 1984. The locations of the two additional wells and the existing wells are shown in Fig. 4.2-1. Monitor Well GW44 was installed to better define the horizontal extent of contamination in the shallow aquifer downgradient of the Yellow Water Reservoir, and Monitor Well GW27D was installed adjacent to the shallow monitor well, GW27, to monitor the ground water in the deep aquifer below the previously documented contamination in the shallow aquifer.

The results of the April 1986 sampling of the 10 wells in the Acids Area/Yellow Water Reservoir area are provided in Table 4.2-1. The spatial distribution of total nitroaromatics (the arithmetic sum of the individual nitroaromatic isomers) is shown in Fig. 4.2-2. Nitroaromatic contamination of the shallow aquifer followed a pattern similar to that observed in the Phase I RI (ESE, 1986d). As shown in Table 4.2-1 and Fig. 4.2-2, nitroaromatic contamination of the shallow aquifer has

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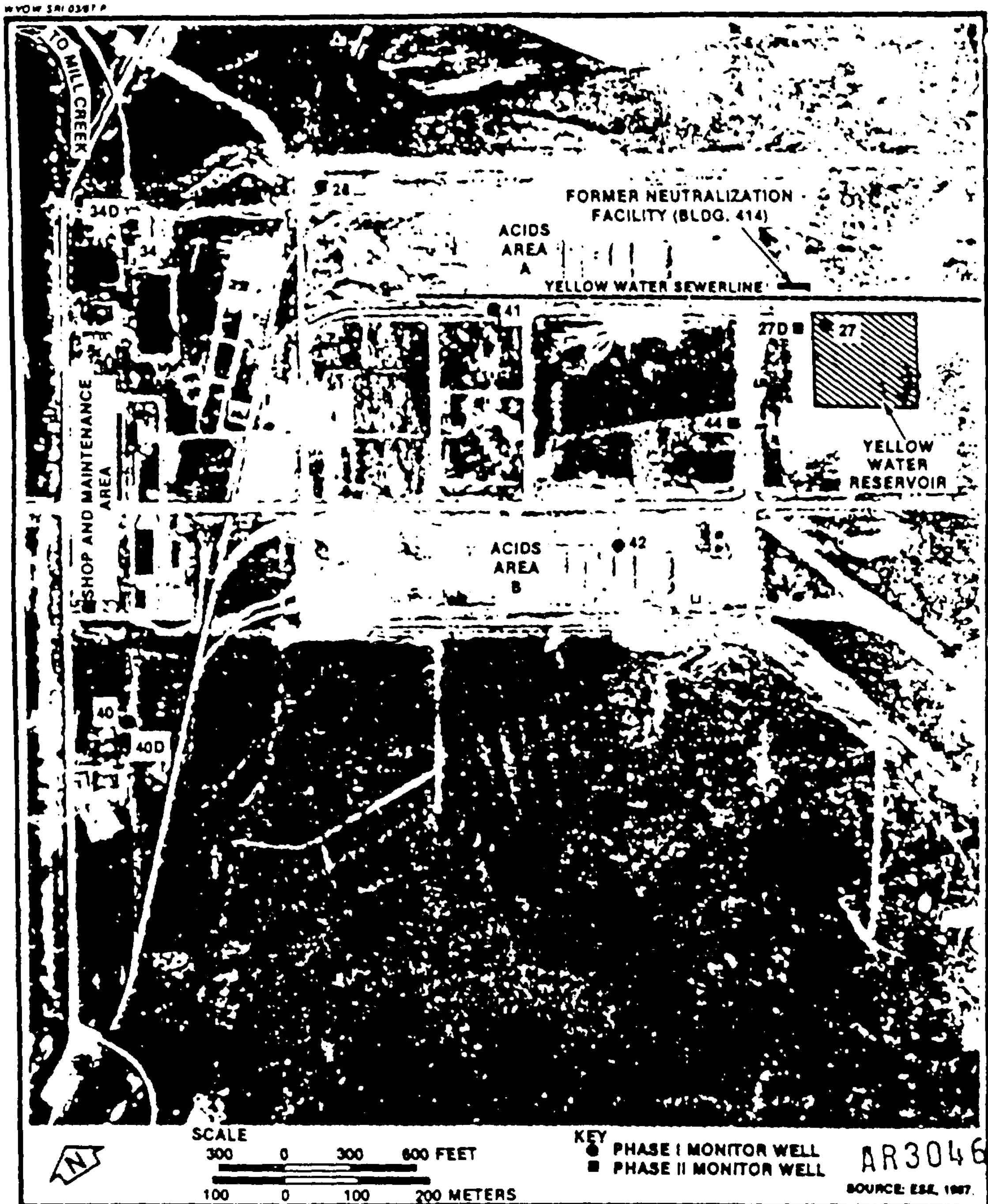

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Figure 4.2-1 LOCATIONS OF GROUND WATER MONITOR WELLS IN THE ACIDS AREA/YELLOW WATER RESERVOIR	WEST VIRGINIA ORDNANCE WORKS Supplemental Remedial Investigation Phase II Field Program

Table 4.2-1. Phase II Chemical Data for Ground Water in the Acids Area/Yellow Water Reservoir

Parameter	Monitor Well and Sampling Date									
	GW34 4/25/86	GW34D 4/25/86	GW40 4/26/86	GW40D 4/28/86	GW28 4/28/86	GW41 4/28/86	GW42 4/25/86	GW27 4/28/86	GW27D 4/28/86	GW44 4/28/86
pH, field (standard units)	5.30	6.50	5.00	6.50	5.40	5.40	5.30	5.30	6.60	5.90
Specific conductance, field (µmho/cm)	430	205	207	187	65.0	205	55.0	126	212	86.0
Water temperature (°C)	15	15	14	15	12	14	14	14	15	14
Nitrobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-DNB (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	0.8	<0.2	<0.2	4	<0.2
TNB (µg/L)	<2	<2	<2	<2	<2	<10*	<2	30	7	<10*
2,4-DNT (µg/L)	<0.3	<0.3	<0.3	<0.3	<0.3	7	<0.3	7	0.5	<0.3
2,6-DNT (µg/L)	<0.8	<0.3	<0.8	<0.8	<0.8	3	<0.8	<0.8	<0.8	<0.8
2,4,6-TNT (µg/L)	<0.08	<0.08	<0.08	<0.08	<0.08	4	<0.08	20	5	<0.2*
Total nitroaromatics† (µg/L)	<3.9	<3.9	<3.9	<3.9	<3.9	10	<3.9	60	20	<12

*Refer to Sec. 4.1, paragraph 3 regarding elevated detection limit.
†Arithmetic sum of the six nitroaromatic isomers (calculated).

Note: µg/L = micrograms per liter.

Source: ESE, 19[illegible].

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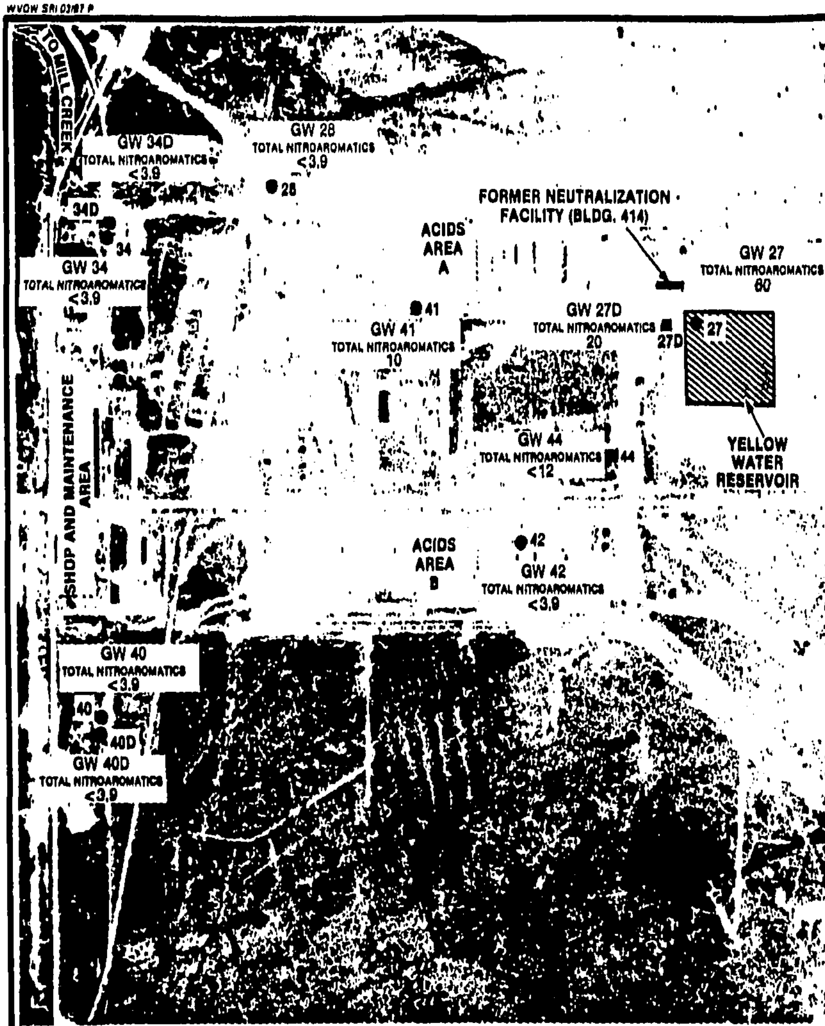

KEY
- ● PHASE I MONITOR WELL
- ■ PHASE II MONITOR WELL

N

SCALE
300 0 300 600 FEET
100 0 100 200 METERS

NOTE: CONCENTRATIONS ARE IN µg/L.

AR301639

SOURCE: ESE, 1987.

Figure 4.2-2 TOTAL NITROAROMATIC CONCENTRATIONS IN THE GROUND WATER — ACIDS AREA/ YELLOW WATER RESERVOIR, APRIL 1986	WEST VIRGINIA ORDNANCE WORKS Supplemental Remedial Investigation Phase II Field Program

occurred at Monitor Wells GW27 and GW41, with higher concentrations observed at GW27. Phase II resampling confirmed that contamination of ground water had occurred beyond the McClintic Wildlife Station boundary. The shallow aquifer in this area is not currently used as a source of drinking water.

As shown in Table 4.2-1 and Fig. 4.2-2, no nitroaromatic compounds were detected in any of the other shallow wells in this area. These results are similar to the Phase I sampling. Monitor Well GW44, installed several hundred feet downgradient of the Yellow Water Reservoir, also did not contain detectable levels of nitroaromatics. The elevated detection limit at GW44 in the Phase II survey is discussed in Sec. 4.1. In this instance, the detection limits for 2,4,6-TNT and 1,3,5-TNB were raised to compensate for low spike recoveries in the QC samples. Specifically, the 2,4,6-TNT detection limit was raised to the 2X level from 0.08 μg/L to 0.2 μg/L), and the 1,3,5-TNB detection limit was raised to the 5X level (from 2 μg/L to 10 μg/L). The 8-μg/L increase in the 1,3,5-TNB detection limit accounted for most of the increase in the detection limit for total nitroaromatics. It is important to note that the total nitroaromatics values used throughout this report are simply the arithmetic sum of the individual constituents and are not values produced in a specific chemical analysis. To assess the impact of the elevated detection limits, the values of the individual nitroaromatic isomers at GW44 were compared with the values observed at GW27, located at the Yellow Water Reservoir. In both wells (April 1986 sampling), levels of nitrobenzene, 1,3-DNB and 2,6-DNT were below detection limits. The concentration of TNB at GW27 decreased from 30 μg/L to less than 10 μg/L at GW44. For 2,4-DNT, the concentration at GW27 of 7 μg/L decreased to less than 0.3 μg/L at GW44. For 2,4,6-TNT, the concentration of 20 μg/L at GW27 decreased to less than the detection limit of 0.2 μg/L at GW44. It was concluded that the absence of contamination observed at GW44 effectively defines the extent of contamination downgradient of the Yellow Water Reservoir.

These data indicate that ground water contamination is occurring only in the immediate vicinity of the Yellow Water Reservoir and is more attributable to the yellow water sewerline. As described in the Phase I RI (ESE, 1986d), soils underlying the Yellow Water Reservoir and along the bed of the yellow water sewerline were found to contain nitroaromatic contaminants. Additionally, soils collected in the Yellow Water Reservoir during the September 1985 reactivity sampling were found to contain up to 2,830 µg/g (dry-weight) of 2,4,6-TNT. This residual nitroaromatic contamination in the soils and sediments is a continuing source for nitroaromatic contamination of the ground water. No ground water contamination is occurring from either the Acids Area or the north and south powerhouses.

The sample of reservoir sediment analyzed for reactivity was determined to be nonreactive. The reactivity testing program was described in the Feasibility Study (FS) report for the first operable unit at WVOW (ESE, 1986c).

The deep well (GW27D) installed near the Yellow Water Reservoir contained detectable levels of 1,3-DNB, trinitrobenzene (TNB), 2,4-DNT, and 2,4,6-TNT (see Table 4.2-1). It should be noted that this well is screened in the aquifer that is used as a potable source in this area. Nitroaromatic compounds have not been detected in either of the deep wells at the powerhouses (GW40D and GW34D) or in the deep well at the McClintic Wildlife Station (DGHW). The deep wells are screened in the same aquifer as GW27D.

The observed contaminant levels and the relative concentration of the various nitroaromatic compounds (compared with those observed in the shallow well, GW27) indicate the possibility that some contaminated ground water from the shallow aquifer may have leaked to the deep aquifer during the installation of Well GW27D. Review of the drilling log for GW27D indicates that three separate borings were attempted before the well could be installed. The first two borings, located approximately 30 ft west and 36 ft southwest of GW27D, were abandoned by grouting.

The primary difficulty in the construction of this well was related to breaks in the steel drive casing which occurred as the casing was driven ahead of the drill bit or as the casing was removed during well construction. The logs for the first two attempts to install Well GW27D indicate that the casing breaks occurred at depth intervals either within or below the gray clay zone. The problems encountered during placement and/or removal of the drive casing may have been partially or completely attributable to increased skin friction or adhesion between the casing and the gray clay. When the first two borings were abandoned, grout was pumped into the drive casing before the casing was removed, resulting in a positive pressure gradient from the boring into both aquifer zones. Therefore, at no time did a direct connection between the shallow contaminated aquifer and deeper potable aquifer exist.

The third and final attempt to install Well GW27D also encountered difficulties related to parting of the drive casing; however, the circumstances were significantly different from those for the first two attempts. The drive casing broke at a depth of 30 ft below the land surface, which was approximately 14 to 15 ft below the elevation of the shallow ground water surface. Shallow ground water was able to migrate down the drive casing into the deeper aquifer during the period of time the break was below the shallow ground water level. Review of the boring log indicates that once the break in the drive casing was identified, an immediate attempt to pull the casing up (i.e., to a position above the shallow ground water level) was initiated. Approximately 2 hours elapsed before this procedure was completed. During this period of time, shallow ground water was able to flow downward through the drive casing into the deeper aquifer. The presence of contaminants in the deeper aquifer (Well GW27D) is attributed to this temporary interconnection of the two water-bearing zones.

4.2.3 TIME-SERIES SAMPLING RESULTS

In August 1986, a time-series sampling of Well GW27D was conducted to determine if the nitroaromatic contaminants had been dispersed in the deep aquifer or if the concentrations observed in the April 1986 sampling persisted. During the time-series sampling, Well GW27D was pumped continuously for 51 hours at the rate of 8 to 9 gallons per minute (gpm) to achieve a continuous drawdown goal of approximately 40 ft. During the pumping, seven samples were collected using a bailer. Samples were also collected from the shallow well, GW27, to coincide with the GW27D samples. Water-level measurements were also made in GW27. Well GW27 was not pumped during this sampling. Water-level measurements for both wells are shown in Table 4.2-2.

The results of the time-series sampling for Wells GW27 and GW27D are given in Tables 4.2-3 and 4.2-4, respectively. Fig. 4.2-3 shows the relationship of total nitroaromatics as a function of time for both wells. As shown, levels of total nitroaromatics in the deep aquifer decreased from 70 to 5 µg/L during the time-series pumping. The prepumping sample containing 70 µg/L of total nitroaromatics is likely not representative of true aquifer water quality. The early pumping phases samples containing 40 µg/L are considered representative.

The geochemical and geohydrological data sets derived from the time-series sampling indicate that the shallow aquifer is not a continuous source of the contamination detected in the deeper aquifer. During the pumping of GW27D, the concentration of nitroaromatic compounds in the shallow aquifer (Well GW27) remained relatively constant at approximately 60 µg/L. In addition, no water-level fluctuations were observed in the shallow aquifer even though drawdown of 40 ft was maintained in the underlying aquifer. These data strongly suggest that no hydraulic connection exists between the two aquifers in this study area.

Table 4.2-2. Time-Series Sampling Water-Level Measurements--
August 11-13, 1986

Date	Time	Water Level*	Comments
Well GW27			
8/11/86	1138	14.71	Prepumping
	1929	14.75	
	2225	14.83	
8/12/86	0053	14.77	
	0858	14.82	
	1210	14.77	
	1350	14.76	
	1607	14.79	
	1902	14.79	
	2245	14.78	
8/13/86	1425	14.78	
	1709	14.78	
	1811	14.79	
Well GW27D			
8/11/86	1733	16.67	Prepumping water level
	1733	16.67	Pump on; flow rate 20 gpm
	1734	43.0	
	1735	55.98	
	1736	80+	Pump wiring and hose interfering with probe access
	1740	104+/-	Water level at pump intake
	1740	104+/-	Pump off
	1822	17.38	End recovery; pump on
	1823	33.20	
	1825	51.82	10 gpm
	1826	56.30	
	1828	60.09	9 gpm
	1829	61.25	8.5 gpm
	1831	62.55	
	1834	56.32	7 gpm, adjusting flow
	1837	55.26	8 gpm
	1841	58.81	9 gpm

AR304644

Table 4.2-2. Time-Series Sampling Water-Level Measurements--
August 11-13, 1986 (Continued, Page 2 of 2)

Date	Time	Water Level*	Comments
Well GW27D (Continued)			
	1844	61.11	
	1921	31.10	Discharge valve clogged
	2000	59.8	9 gpm
	2034	--	Generator out of gas
	2053	23.0	Restart
	2145	43.53	8 gpm
8/12/86	0340	47.48	
	0853	57.04	
	1216	59.85	8 gpm
	1354	59.70	8 gpm
	1605	60.46	8 gpm
	1900	61.25	
	2243	53.75	8 gpm
8/13/86	0053	54.23	8 gpm
	0555	55.07	
	1330	55.66	9 gpm
	1430	55.75	
	1707	56.02	
	1808	56.48	9 gpm
	1830	56.59	Pump off

*Water-level measurements in feet from top of PVC casing.

Source: ESE, 1987.

Table 4.2-3. Chemical Results of Time-Series Sampling of Monitor Well GW27 (Shallow Aquifer)

Parameter	Date:	08/11/86				08/12/86		08/13/86
	Time:	1805	1830	1910	2232	0740	1830	1845
pH, field (standard units)		5.94	6.62	6.00	6.40	6.29	6.94	6.06
Specific conductance, field (µmho/cm)		88.0	89.0	94.0	110	110	102	102
Water temperature (°C)		16	17	16	14	13	16	16
Nitrobenzene (µg/L)		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-DNB (µg/L)		<1*	<0.5	0.9	0.9	0.9	0.9	0.7
TNB (µg/L)		40	30	20	30	30	40	30
2,4-DNT (µg/L)		6	4	5	6	5	6	5
2,6-DNT (µg/L)		<4*	2	5	<8*	<8*	<8*	<8*
2,4,6-TNT (µg/L)		30	30	10	20	20	20	20
Total nitroaromatics† (µg/L)		80	70	40	60	60	70	60
Nitrate + nitrite (µg/L as N)		1,000	1,000	1,000	1,000	1,000	1,000	1,000

*Refer to Sec. 4.2.2, paragraph 3.
†Arithmetic sum of the six nitroaromatic isomers (calculated).

Note: N = nitrogen.

Source: ESE, 1987.

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Table 4.2-4. Chemical Results of Time-Series Sampling of Monitor Well GW27D (Deep Aquifer)

Parameter Date:	08/11/86				08/12/86		08/13/86
Time:	1512	1748	1855	2215	0210	1757	1810
pH, field (standard units)	8.30	8.00	7.02	8.30	6.94	9.07	9.20
Specific conductance, field (μmho/cm)	180	201	209	215	220	265	280
Water temperature (°C)	17	18	16	26	14	16	17
Nitrobenzene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-DNB (μg/L)	5	3	2	2	2	3	2
TNB (μg/L)	50	30	20	30	30	30	<2
2,4-DNT (μg/L)	0.8	0.6	0.7	0.7	0.9	0.5	0.6
2,6-DNT (μg/L)	<4*	<4*	<4*	<4*	<4*	1	<4*
2,4,6-TNT (μg/L)	10	7	7	6	6	5	2
Total nitroaromatics† (μg/L)	70	40	30	40	40	40	5
Nitrate + nitrite (μg/L as N)	700	500	400	500	500	600	500
Alkalinity, total (mg/L as $CaCO_3$)	37.0	57.0	70.0	71.0	81.5	114	110

*Refer to Sec. 4.2.2, paragraph 3.
†Arithmetic sum of the six nitroaromatic isomers (calculated).

Note: $CaCO_3$ = calcium carbonate.
mg/L = milligrams per liter.

Source: ESE, 1987.

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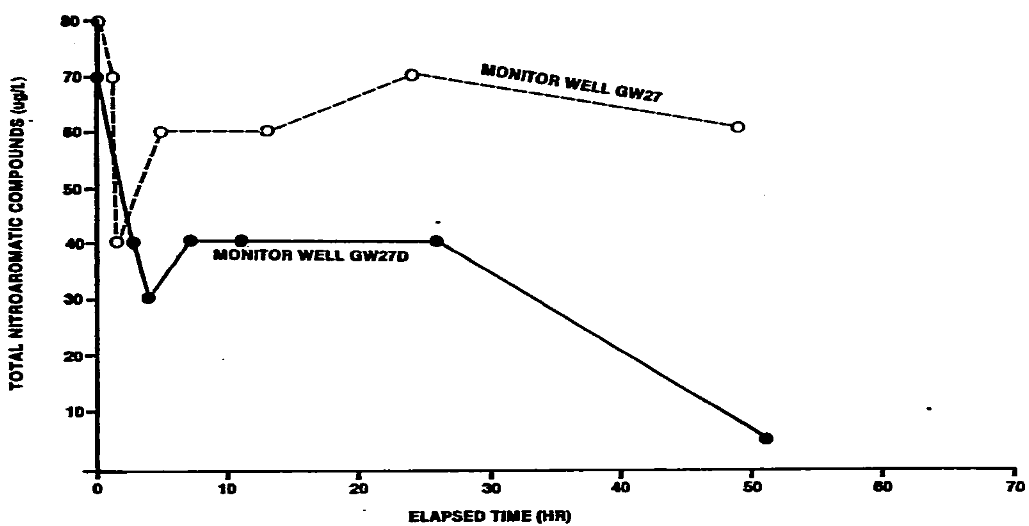

SOURCE: ESE, 1987.

Figure 4.2-3
RESULTS OF TIME-SERIES SAMPLING OF MONITOR WELLS GW27 AND GW27D — YELLOW WATER RESERVOIR

WEST VIRGINIA ORDNANCE WORKS
Supplemental Remedial Investigation
Phase II Field Program

The gray clay layer, with an average thickness of approximately 20 ft, was identified on the drilling logs from the three deep wells in the area (GW27D, GW34D, and GW40D). The data from these wells provide sufficient detail to accurately define the continuity of the clay at this study area. Vertical flow from the shallow contaminated aquifer to the deeper zone, through the clay layer, was estimated to occur at a rate of 1.7×10^{-4} ft/day (see Sec. 3.3). It is unlikely, therefore, that the contaminant levels detected in Well GW27D are the result of shallow contamination migrating through the clay layer. The break in the drive casing described in Sec. 4.1.3 is the most realistic source of the observed contamination in the deeper aquifer.

Using the geohydrological parameters developed for the Yellow Water Reservoir and the timing of certain key events, the radius of the area around Well GW27D affected by the drilling and time-series sampling can be estimated. The ground water flow rate in the deeper aquifer at this study area was found to be 6×10^{-3} ft/day. Approximately 4 months (122 days) elapsed between the temporary interconnection of the deep and shallow aquifers and the initiation of the time-series sampling. During this time, contaminants introduced during drilling at GW27D may have migrated up to 1 ft from the well under the influence of the natural ground water gradient. Therefore, it may be assumed that the contaminants introduced at Well GW27D had not migrated a significant distance from the well by the time the time-series sampling was initiated.

During the time-series sampling, approximately 26,000 gallons (gal) of water was extracted from the deeper aquifer. A first approximation of the volume of saturated aquifer affected by this quantity of pumping can be calculated as follows:

$$V = \frac{\text{volume of water extracted (gal)}}{[7.48 \text{ gal/ cubic feet } (ft^3)] \text{ porosity}}$$

$$V = \frac{26,000}{(7.48) \times (0.25)}$$

$$V = 13,900 \text{ ft}^3$$

where: V = volume of aquifer affected by pumping.

Using the assumption that the thickness of the aquifer that yielded water to Well GW27D during the pumping was equal to the thickness of the screened interval (15 ft), the radius of a circular area around the well affected by the pumping can be estimated as follows:

$$r = \sqrt{\frac{\text{volume of aquifer } (ft^3)}{\text{effective thickness (ft)} \times (\pi)}}$$

$$r = 17 \text{ ft}$$

where: r = radius of aquifer affected by pumping.

Additional data which would allow further refinement of the calculation of the radius of the affected area around the well are not available.

Well GW27D is located approximately 30 ft east (upgradient) of the locations of the first two attempts to construct the well. The well log, described previously, seems to indicate that no contamination was introduced to the deeper aquifer during the drilling at the first two well sites. Therefore, the ground water in the vicinity of the two borings may be expected to be free from nitroaromatic contamination. Additionally, because each of the two initial well bores was abandoned by grouting, an unnatural source of high alkalinity and pH (i.e., the grout)

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is present in the vicinity of the abandoned borings. The low ground water gradient in the deeper aquifer would not have allowed this source of high alkalinity and pH to dissipate in the period of time since emplacement of the grout.

Review of the geochemical data from the time-series sampling indicates the following:

1. After initial fluctuations in the concentration of total nitroaromatics caused by initiation of pumping, the contaminant level temporarily equilibrated at a value of approximately 40 µg/L.
2. The final sample obtained just prior to cessation of pumping indicated a dramatic reduction in the level of total nitroaromatic contamination.
3. Coincident with the reduction of detected nitroaromatic contamination, an increase in both alkalinity and pH was detected.
4. Throughout the duration of the time-series pumping, the nitrate + nitrite levels remained constant.

The equilibrium (temporary) value of 40 µg/L of total nitroaromatics in the deeper aquifer is representative of the level of contamination in the vicinity of the well bore caused by the temporary interconnection of the shallow and deeper aquifers during well construction. Estimates of potential migration of this contamination away from the vicinity of the well bore under the influence of the natural gradient presented previously indicate that insufficient time had elapsed from the time of drilling to initiation of the time-series sampling to allow significant migration of contaminants from the immediate vicinity of the well.

The first approximation (17 ft) of the radius of the aquifer zone around Well GW27D affected by the pumping may be underestimated. The increase in alkalinity and pH detected in samples collected in the later portion of the pumping period strongly suggests that ground water from the vicinity of the first two well bores was reaching Well GW27D at a much earlier time than that indicated by the approximation. As stated previously, the well logs for the first two borings do not indicate that an interconnection between the two aquifer zones was ever operative, suggesting that the ground water in the vicinity of the bores was free from nitroaromatic contamination. If the increases in alkalinity and pH are attributed to arrival of "clean" water from 30 ft away, a decrease in the levels of nitroaromatic contamination would also be expected during the later stages of pumping as the "clean" water reached the pumped well. The chemical data for nitroaromatic compounds are consistent with this model. In comparison, levels of a naturally occurring chemical constituent of the deeper ground water (nitrate + nitrite) remained constant during the period of pumping.

The time-series sampling effectively demonstrated that the contamination of the deeper aquifer was the result of the documented temporary interconnection of the contaminated shallow aquifer with the deeper aquifer, and that the contamination has been significantly reduced by the pumping of the deeper aquifer.

4.3 RED WATER RESERVOIRS

4.3.1 REVIEW OF PHASE I RI RESULTS

During the Phase I RI, six monitor wells were installed in the vicinity of the Red Water Reservoirs. Three wells were installed immediately adjacent to the reservoirs, and three wells were installed along the lower Mill Creek drainage. As described in the Phase I RI report (ESE, 1985d), no nitroaromatic contamination was observed along the Mill Creek drainage. Contamination, however, was detected in the shallow aquifer adjacent to the former reservoirs.

4.3.2 PHASE II RESULTS

4.3.2.1 Ground Water

The Phase II RI investigations in the Red Water Reservoirs area included the installation and sampling of four additional wells plus the resampling of the six existing wells that had been installed during the initial RI survey. The locations of the four additional wells (GW45, GW45D, GW46, and GW47) are shown in Fig. 4.3-1. As shown, these wells are located northwest of the former reservoirs. Monitor wells GW45 and GW45D are a monitor well pair designed to monitor the shallow aquifer as well as the deep, confined aquifer adjacent to and downgradient of the former reservoirs. Monitor Wells GW46 and GW47 were installed to monitor the shallow aquifer downgradient of the former reservoirs. These additional wells were installed based on the pronounced ground water gradient that was observed during the Phase I RI survey. The location of the Schwartz (SHW6) well and GW33 relative to the Red Water Reservoirs area is shown on Fig. 2.1-3.

The results of the April 1986 sampling of the 10 wells in this area are given in Table 4.3-1. The areal concentration distribution of total nitroaromatics (the arithmetic sum of the individual nitroaromatic isomers) is shown in Fig. 4.3-2. The pattern of contamination observed in April 1986 was similar to the previous sampling conducted during the Phase I RI survey. As shown, no contamination was observed in Monitor

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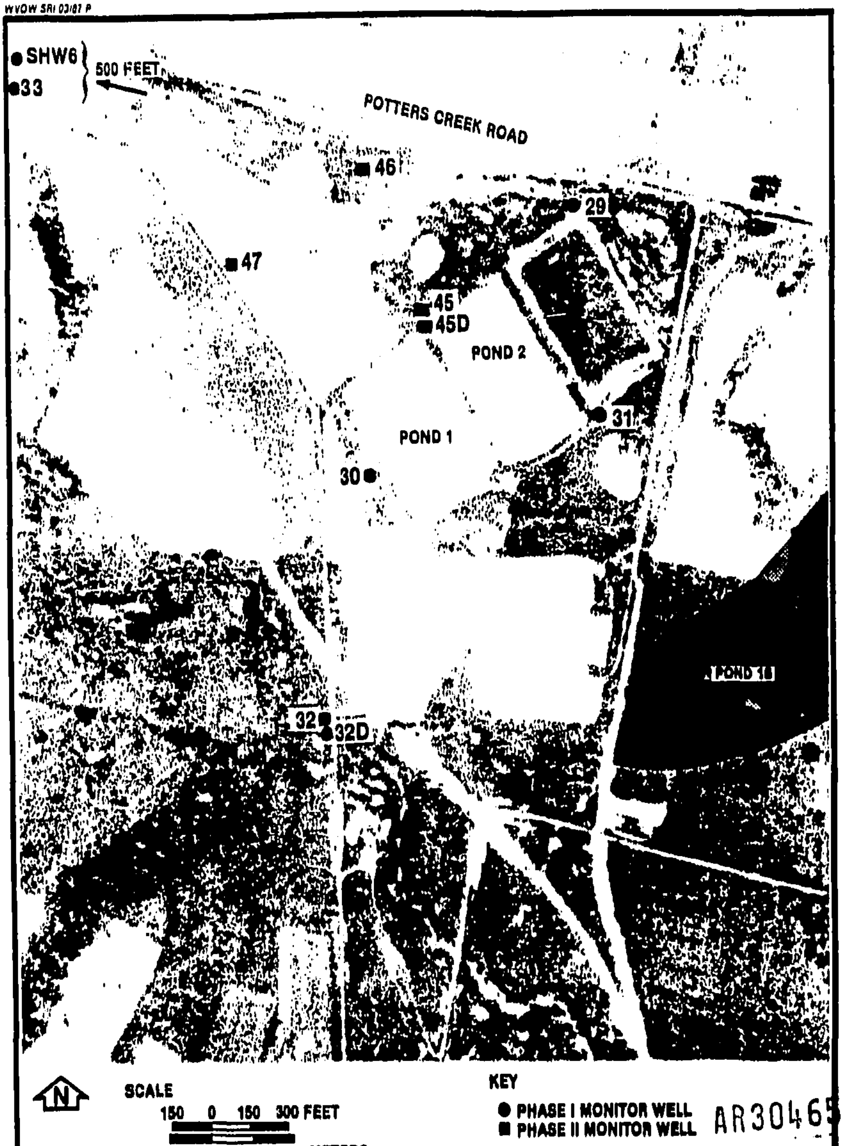

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SOURCE: ESE, 1987.

Figure 4.3-1 LOCATIONS OF GROUND WATER MONITOR WELLS IN THE RED WATER RESERVOIRS, APRIL 1986	WEST VIRGINIA ORDNANCE WORKS Supplemental Remedial Investigation Phase II Field Program

Table 4.3-1. Phase II Chemical Data for Ground Water in the Red Water Reservoirs, April 1986

Parameter	Monitor Well Number and Sampling Date										
	GW29 4/24/86	GW30 4/28/86	GW31 4/24/86	GW32 4/27/86	GW32D 4/23/86	GW33 4/29/86	GW45 4/28/86	GW45D 4/26/86	GW46 4/28/86	GW47 4/28/86	SW46 4/26/86
pH field, standard units	6.00	5.80	5.70	6.20	6.80	6.70	5.80	8.00	6.30	6.10	7.30
Specific conductance, field (μmho/cm)	243	214	225	212	196	606	264	287	286	401	500
Water temperature (°C)	15	14	14	17	12	12	15	15	15	14	17
Nitrobenzene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5*	<0.5
1,3-DNB (μg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2	0.4	2	1
TNB (μg/L)	<2	10	<2	2	<2	<10.0†	90	<2	<2	<20*	<2
2,4-DNT (μg/L)	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	7	<0.3	<0.3	30	<0.3
2,6-DNT (μg/L)	<0.8	2	<0.8	<0.8	<0.8	<0.8	20	<0.8	<0.8	<8*	<0.8
2,4,6-TNT (μg/L)	<0.08	2	<0.08	<0.08	<0.08	<0.2†	30	0.3	1	5	0.2
Total nitroaromatics** (μg/L)	<3.9	10	<3.9	<3.9	<3.9	<11.8	100	2	1	40	1

*Refer to Sec. 4.1, paragraph 3.
†Refer to Sec. 4.1, paragraph 4.
**Arithmetic sum of the six nitroaromatic isomers (calculated).

Source: ESE, 1987.

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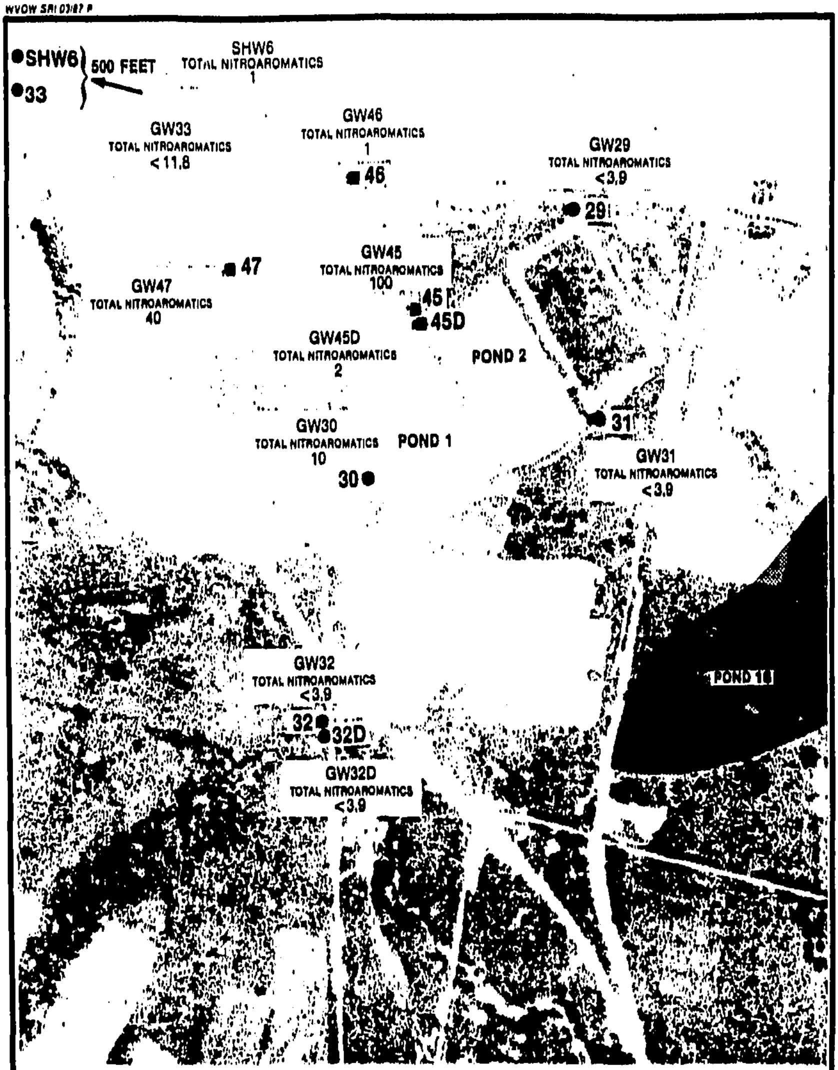
WVOW SRI 03/87 P



KEY
- ● PHASE I MONITOR WELL
- ■ PHASE II MONITOR WELL

NOTE: CONCENTRATIONS ARE IN ug/L

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Figure 4.3-2 TOTAL NITROAROMATIC CONCENTRATIONS IN THE GROUND WATER IN THE RED WATER RESERVOIRS, APRIL 1986	WEST VIRGINIA ORDNANCE WORKS Supplemental Remedial Investigation Phase II Field Program

AR304656

Wells GW29, GW31 (located adjacent to but upgradient of the reservoirs) and GW32, GW32D, or GW33 (located along the Mill Creek drainage). The April 1986 sample from Monitor Well GW33 did not contain detectable nitroaromatics. Because of low spike recoveries in the QC samples, the detection limits for 2,4,6-TNT and TNB were raised to the 2X and 5X detection limits, respectively (where X represents the analytical detection limit for the certified method). Although the detection limits were elevated for this sample, the 2,4,6-TNT limit of 0.16 μg/L provides an adequate data point to indicate that the well is unaffected by nitroaromatic contamination.

As shown in Table 4.3-1 and Fig. 4.3-2, nitroaromatic compounds were detected in Monitor Wells GW30, GW45, GW45D, GW46, GW47, and SHW6, all of which are located downgradient of the former reservoirs. Well SHW6 and GW33 are off the scale of Fig. 4.3-2 and are shown on the site map, Fig. 2.1-3. Total nitroaromatic compounds ranged from 2 to 200 μg/L in the downgradient shallow aquifer. The concentration of nitroaromatics observed in Monitor Well GW30 (10 μg/L) was approximately the same as the level reported during the previous RI survey (16.6 μg/L). The highest concentration (200 μg/L) was observed in the shallow aquifer at Monitor Well GW45, which is located immediately downgradient of the former reservoirs.

These additional data indicate contaminant migration has occurred beyond the McClintic Wildlife Station property boundary. In addition, the April 1986 sampling of the Shwartz well revealed low but detectable levels of 1,3-DNB (1 μg/L) and 2,4,6-TNT (0.2 μg/L). No nitroaromatic contamination of the Shwartz well was reported in the 1985 sampling. A review of the chromatograms generated during the 1985 analysis indicated that contaminant peaks were identifiable but were below the 1985 certified detection limits. This well is not utilized as a potable source.

The deep well (GW45D) installed downgradient of the former reservoirs contained detectable levels of 1,3-DNB and 2,4,6-TNT (see Table 4.3-1). This well was screened in the deep aquifer below the gray clay confining bed. This well and Monitor Wells GW45 and GW47 were resampled during August 1986 (see Table 4.3-2). Contaminant levels observed in GW45 and GW47 were consistent with the results of the April 1986 sampling. The concentrations observed in the deep well GW45D warranted a thorough evaluation. In GW45D, the concentration of total nitroaromatics increased from 2 µg/L in April to 7 µg/L in August. The increase was due to a marked rise in the 1,3-DNB concentration, which increased from 2 µg/L in April 1986 to 7 µg/L in August 1986. However, during this same period, the concentration of 2,4,6-TNT decreased from 0.3 µg/L to below the detection limit of 0.08 µg/L. Although one constituent increased, the only other constituent detected in the April sample decreased to below the detection limit in this 4-month period. The remaining nitroaromatic compounds were below the detection limits in the April and August samples.

At these trace levels, an increase of 5 µg/L in total nitroaromatics concentration cannot be considered significant given the analytical uncertainty associated with summing the analytical results for six individual constituents. Based on the April and August results, it can be concluded that no apparent increase was evident in nitroaromatic concentration.

The areal extent and thickness of the gray clay confining layer was defined using information from Wells GW30, GW32D, GW45D, and GW47. At GW45D, the clay extended to a thickness of 23 ft. Employing water-level data from GW45 and GW45D, a vertical flow potential of 1×10^{-3} ft/day was calculated.

The continuity and thickness of the gray clay should effectively limit vertical contaminant migration to the lower aquifer. The results of the

Table 4.3-2. Phase II Chemical Data for Ground Water in the Red Water Reservoirs, August 1986

Parameter	Monitor Well GW45	GW45D	GW47
pH, field (standard units)	6.36	8.13	6.53
Specific conductance, field (µmho/cm)	210	232	291
Water temperature (°C)	15	16	16
Nitrobenzene (µg/L)	<0.5	<0.5	<0.5
1,3-DNB (µg/L)	<0.2	7	1
TNB (µg/L)	100	<2.0	<20*
2,4-DNT (µg/L)	1	<0.3	20
2,6-DNT (µg/L)	20	<0.8	<8*
2,4,6-TNT (µg/L)	40	<0.08	6
Total nitroaromatics† (µg/L)	200	7	30
Nitrite + nitrate (µg/L as N)	3,000	10	4,000
Total alkalinity (mg/L as $CaCO_3$)	NA	128	NA

*Refer to Sec. 4.2.2, paragraph 3.
†Arithmetic sum of the six nitroaromatic isomers (calculated).

Note: NA = Not analyzed.

Source: ESE, 1987.

time-series sampling at GW27D in the Yellow Water Reservoir area indicated that the low levels of contaminants may have been introduced into the deeper aquifer during well installation. A similar situation had also occurred at GW36D in the TNT Manufacturing Area. Resampling of GW36D in April 1986 indicated that contamination was not present in the deep aquifer at the TNT Manufacturing Area. Based on these circumstances, it appears likely that the contaminants were introduced to the deep aquifer during well installation.

4.3.2.2 Sediments

Sediment sampling of Ponds 1 and 2 during the initial RI survey revealed low levels of nitroaromatics in the sediments of both ponds (ESE, 1986d). In the Phase II program, vertical composite samples were collected below the interval of each Phase I sample. In addition, a large areal composite sample was collected at Pond I during the reactivity sampling program in September 1985.

The nitroaromatic concentrations observed in the Phase I and Phase II surveys were consistent (Table 4.3-3); however, the 2,4,6-TNT concentration in the reactivity composite sample (2,210 µg/g dry weight) was several orders of magnitude higher than the Phase I or II results. The samples collected in the Phase I program were discrete samples; in Phase II, vertical composite samples were collected by coring below the interval of each Phase I sample. In contrast, the reactivity areal composite sample was collected from a trench dug in a dry area of the pond during low-water conditions. The difference in the sample collection procedures may account for the difference in the observed concentrations in the reactivity program compared to the results of the Phase I and II samples. The higher concentrations observed in the sample are likely due to hot spots in the sediments encountered during the composite sampling. Further information describing the reactivity testing program in detail is contained in the FS report for the first operable unit at WVOW (ESE, 1986c).

AR304660

Table 4.3-3. Phase II Chemical Data for Sediments in the Red Water Reservoirs

Parameter	Sample Designation					
	P1F	P1F2	P1F3	P2F	P2F2	P2F3
Sampling Date:	04/25/86	04/24/86	04/24/86	04/23/86	04/24/86	04/24/86
Sample Type:	VC*	VC	VC	VC	VC	VC
Sampling Interval (ft)†:	2.0 - 3.5 4.2 - 5.4**	2.0 - 3.5	2.0 - 3.5	1.7 - 4.8	2.0 - 3.8	2.0 - 3.5
Nitrobenzene (µg/g)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,3-DNB (µg/g)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,3,5-TNB (µg/g)	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
2,4-DNT (µg/g)	<0.10	<0.10	0.26	<0.10	1.2	0.51
2,6-DNT (µg/g)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
2,4,6-TNT (µg/g)	<0.10	<0.10	<0.10	<0.10	0.36	<0.10
Moisture (% Wet Weight)	20.4	23.5	6.4	14.2	5.2	0.9

*VC = vertical composite sample.
†Sampling interval measured from top of sediment.
**Interval from 3.5 to 4.2 ft not included in composite sample.

Source: ESE, 1987.

AR304661

The concentrations observed in the Pond 1 and 2 sediments were shown to be a source of shallow ground water contamination at the Red Water Reservoirs area. In addition, the red water sewerline is considered a source of ground water contamination at other areas of WVOW and is considered a contributing source of ground water contamination at the Red Water Reservoir. The observed nitroaromatics concentration in the pond sediments, along with the contribution of the red water sewerline, is adequate to account for the observed nitroaromatic contamination in the ground water.

4.4 POND 13/WET WELL AREA

4.4.1 REVIEW OF PHASE I RI RESULTS

The Phase I investigation (ESE, 1986d) in the Pond 13/Wet Well Area involved sampling eight monitor wells: the four previously installed EPA monitor wells (NUS, 1983) plus four wells installed in the fall 1984 (ESE, 1986d). Nitroaromatic contamination was observed during the 1985 RI (ESE, 1986d) in five of the eight monitor wells. Highest concentrations were measured in the shallow, water-table aquifer near the route of the underground red/yellow water trunk sewerline and the two Wet Well Area holding basins.

4.4.2 PHASE II RESULTS

During the Phase II RI (ESE, 1986a), two additional monitor wells (GW48D and GW49) were installed to better delineate the complex geologic characteristics of this area and to provide additional areal coverage and vertical data on the extent of the contaminant plume that was observed during the 1985 sampling. As shown in Fig. 4.4-1, monitor well GW48D was installed just north of Pond 13, and GW49 was installed north and east of Pond 12. A shallow aquifer monitor well also was planned adjacent to the GW48D. The plans for installation of this well, however, were abandoned when clay was encountered during the drilling of GW48D from ground surface to a depth of approximately 75 ft. The Phase II program also included installation of a shallow water-level observation, Well OW32S, west of Well EPA04.

The results of the April 1986 sampling of all 10 wells in the Pond 13/Wet Well Area are presented in Table 4.4-1. Total nitroaromatics values indicated in Table 4.4-1 are the sum (calculated) of the six nitroaromatic compounds. The total nitroaromatic concentrations are plotted in Fig. 4.4-2 to show the spatial distribution of contamination in the shallow aquifer. The pattern of contamination shown in Fig. 4.4-2 is similar to the distribution observed during the 1985 sampling (ESE, 1986d). Highest levels of nitroaromatics (principally 2,4,6-TNT) occur

WVOW SRI 03/97 P

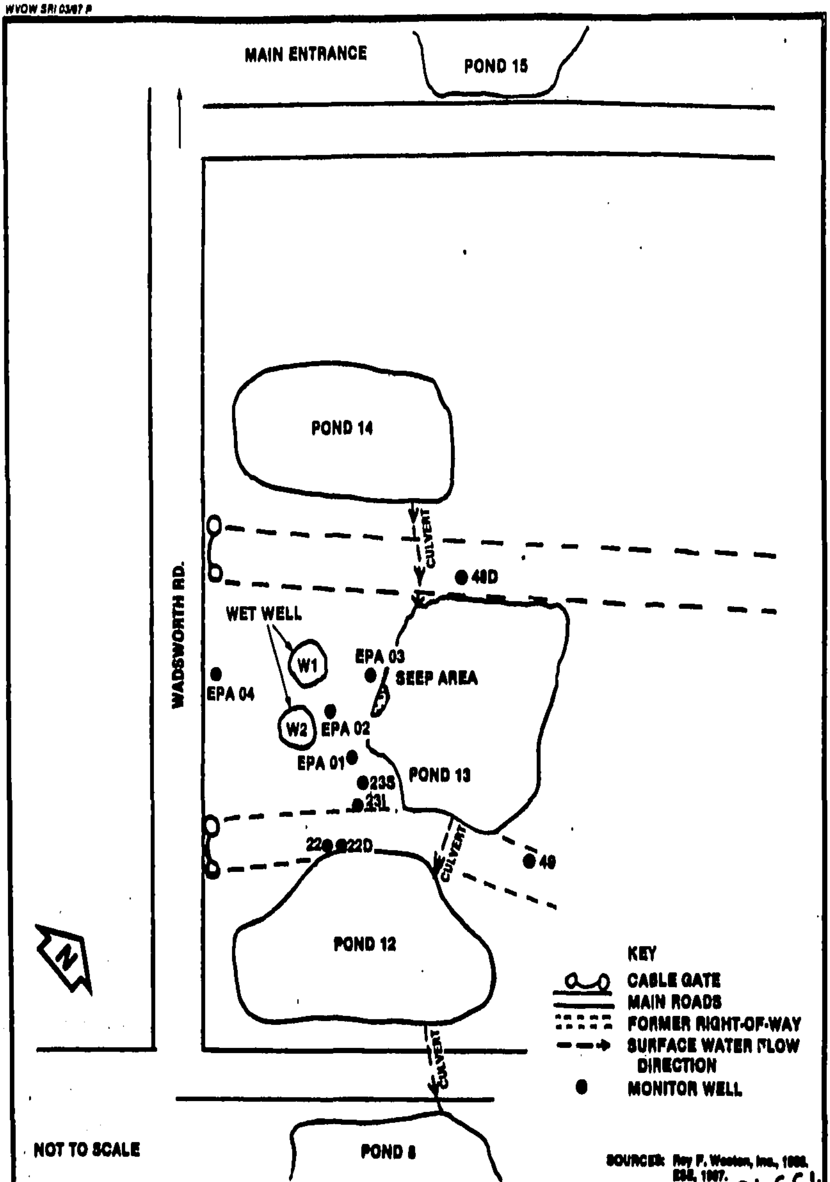

Figure 4.4-1 **LOCATIONS OF GROUND WATER MONITOR WELLS IN THE POND 13/WET WELL AREA**	**WEST VIRGINIA ORDNANCE WORKS** Supplemental Remedial Investigation Phase II Field Program

AR304661

AR304664

Table 4.4-1. Phase II Chemical Data for Ground Water in the Pond 13/Wet Well Area

Parameter	Monitor Well Number and Sampling Date										
	EPA01 4/29/86	EPA02 4/29/86	EPA03 4/29/86	EPA04 4/29/86	GW22 4/27/86	GW22D 4/26/86	GW23S 4/26/86	GW23I 4/26/86	GW48D 4/27/86	GW48D 8/13/86	GW49 4/28/86
pH, field (standard units)	6.40	5.90	6.60	6.30	6.50	6.60	6.30	5.80	6.70	6.56	5.80
Specific conductance, field (µmho/cm)	188	221	189	716	167	154	236	133	178	136	59
Water temperature (°C)	20	14	12	15	16	15	13	14	16	16	14
Nitrobenzene (µg/L)	<0.5	<5*	<50*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-DNB (µg/L)	0.5	6	<20*	<10*	<0.2	<0.2	0.6	0.7	0.9	8	<0.2
TNB (µg/L)	<10††	40	<200†	<10†	<2	<2	<2	<2	<2	<2	<2
2,4-DNT (µg/L)	6	200	800	50	<0.3	<0.3	4	20	<0.3	<0.3	<0.3
2,6-DNT (µg/L)	<20*	20	200	<40*	<0.8	<0.8	2	5	<0.8	<0.8	<0.8
2,4,6-TNT (µg/L)	5	300	2,000	2	<0.08	<0.08	0.6	1	0.08	<0.08	<0.08
Total nitroaromatics** (µg/L)	11.5	600	3,000	50	<3.9	<3.9	7	30	1	8	<3.9

*Refer to Sec. 4.1.2, paragraph 3.
†Refer to Sec. 4.1.2, paragraph 4.
**Arithmetic sum of the six nitroaromatic isomers (calculated).

Source: [illegible], 1987.

WVOW SRI 03/87 P

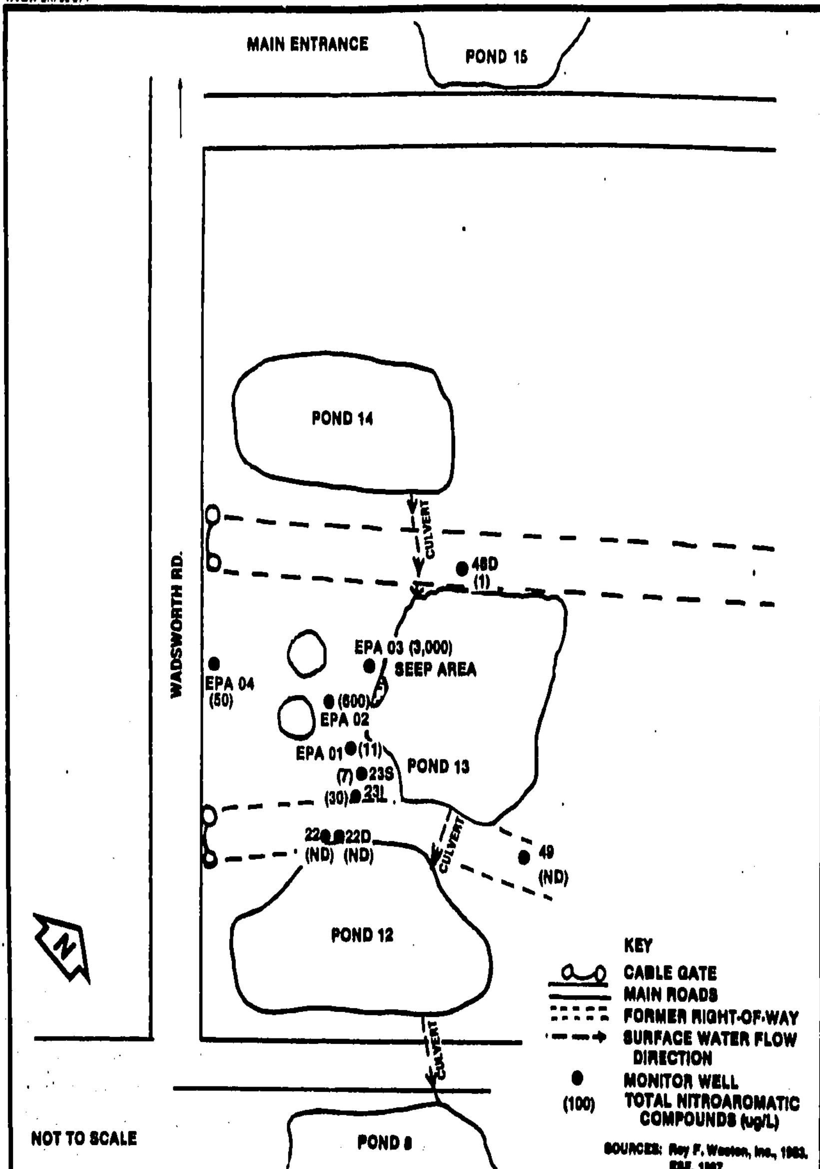

Figure 4.4-2
CONCENTRATIONS OF TOTAL NITROAROMATIC COMPOUNDS IN MONITOR WELLS AND EPA WELLS IN THE POND 13/ WET WELL AREA

WEST VIRGINIA ORDNANCE WORKS
Supplemental Remedial Investigation
Phase II Field Program

AR304666

in the shallow aquifer at EPA monitor wells EPA02 and EPA03 located downgradient of the Wet Well Area and red/yellow water trunk sewerline. As shown in Fig. 4.4-2, these wells are located immediately adjacent to the area of Pond 13 in which red water seepage has occurred. No contamination was observed in GW22 or GW22D during the 1985 sampling, and no nitroaromatics were observed in these wells during the April 1986 Phase II RI. As shown in Fig. 4.4-2, no nitroaromatic contamination was detected in the new monitor well (GW49) that was installed in the shallow aquifer northeast of Pond 12.

The levels of nitroaromatic contaminants observed in April 1986 sampling are lower than the concentrations reported during the Phase I RI (ESE, 1986d). For example, the 2,4,6-TNT concentration in EPA03 was 3,000 µg/L in April 1986; in 1985, the level was 21,000 µg/L. Decreased levels of nitroaromatics also were observed for EPA02. The decreased levels in these wells during April 1986 may be attributable to differences in hydrological regimes. The 1985 sampling occurred in January (winter), and the 1986 sampling occurred in the spring (April). Additionally, the lower levels may be due to dilution by surface runoff. It was very wet during the April 1986 sampling, and a large amount of surface runoff was occurring. The grouting around EPA02 and EPA03 is cracked and deteriorating; therefore, surface runoff is not prevented from leaking into the ground water around the casing.

Based on the spatial distribution of nitroaromatic contaminant concentrations shown in Fig. 4.4-2, the contaminant plume appears to be confined to the immediate vicinity of the two wet wells at the Pond 13 area. Previous studies in this area (NUS, 1983; ESE, 1986d) confirmed that contaminant migration from the shallow aquifer was occurring in the seep area into the surface water of Pond 13. The highly contaminated shallow aquifer in the vicinity of the Wet Wells is upgradient of Pond 13. As described in the initial Phase I RI (ESE, 1986d), the concentrations of nitroaromatics in Pond 13 are greatest in the vicinity

AR304667

of the seep and decrease to low levels in the central and eastern portions of the pond. The observed decrease in concentration is presumably due to dilution, photolysis, and/or biodegradation.

The predominant sources of the high concentrations of nitroaromatics observed in the shallow ground water in the vicinity of Pond 13 are contaminated sediments along the sewer trunkline, contaminated subsurface soils along the bed of the trunk sewerline, and/or the sediments of the Wet Wells. The Phase I RI confirmed the existence of contaminated residues in the sewerlines and subsurface soils along the trunk sewerlines. The sediments of Wet Well No. 1 (W1) have been sampled twice--once during the Phase I RI (ESE, 1986d) and again during the reactivity sampling program. The Phase I RI sediment samples showed low levels of nitroaromatics. The sediment samples collected in September 1985 during the reactivity program, however, showed high levels of 2,4,6-TNT (4,240 µg/g). These samples were collected at a greater depth than previously sampled. During sediment coring, a strong nitroaromatic odor was apparent. Only 2,4,6-TNT was quantified analytically during the reactivity program. Based on this high level and the upgradient location, the sediments of Wet Well No. 1 may be the principal contributing source of nitroaromatic contaminants to the shallow ground water aquifer and the Pond 13 seep.

Given the uncertainty of ground water flow direction beyond the immediate vicinity of Pond 13, additional monitor well installation was considered to provide additional information to refine the shallow ground water flow gradient and to fully define the extent of contamination. While it would be helpful to expand the areal coverage of monitor wells in this area, the existing data base has adequately defined the sources of contamination, source strength, and limit of contamination. Since sufficient data exist for the purposes of the FS (and any potential remedial action, if necessary), further investigation was deemed unnecessary.

AR304668

Particular attention was given to the low levels of nitroaromatics observed at Well GW48D, since this well is screened in the glacial outwash used as a potable source in the surrounding area.

As shown in Figure 3.5-1, cross section E-E' shows that a shallow sand layer was encountered at approximately the same elevation as the contaminated shallow aquifer present at the EPA wells and Well GW23S. The well log for GW48D indicates that the sand at this interval was a dark gray, fine-grained clayey sand with approximately 5 percent gravel. This sand was saturated; its thickness was 3 ft. The sand aquifer present at the EPA wells was a medium- to coarse-grained brown sand. Given this substantial difference in lithology, it was concluded that the sand present at GW48D was discontinuous and was not part of the shallow aquifer at Pond 13. As such, it seems unlikely that the isolated sand unit at GW48D would be contaminated such that this layer could account for the observed contamination at GW48D.

It is interesting to note that the contamination pattern observed at GW48D in the April 1986 and August 1986 samples is remarkably similar to that observed at GW45D. In April, the sample contained 1,3-DNB (0.9 μg/L) and 2,4,6-TNT (0.08 μg/L); total nitroaromatics concentration was 1 μg/L. In August, the DNB value increased to 8 μg/L, whereas the 2,4,6-TNT value decreased to below the detection limit. The remaining constituents were below the detection limits in both sampling rounds.

The concentrations of nitroaromatics observed in the August samples in GW45D and GW48D could be indicative of an analytical error; however, analytical procedures were thoroughly reviewed and no errors were detected.

The nature of the shallow sand layer indicates that it is unlikely to be the source of the contamination observed at GW48D. The analytical data are considered valid. However, the gray clay confining layer is present at Pond 13 and is of adequate areal extent and thickness such that vertical contamination should not be likely.

Water levels measured in the Phase II survey show that a minor upward gradient exists; water levels at the EPA wells are 1.5 ft lower than the observed water levels in GW22D and GW48D. This upward gradient would serve to further minimize the potential for vertical contaminant migration.

Nitroaromatic contaminants were never detected in GW22D or GW22, which are completed in the lower and upper portions of the deep aquifer. These wells are located in proximity to the wet wells; if contamination was present in the deep aquifer, it is likely that nitroaromatics would have been present in these wells.

An additional shallow monitor well, GW43, was installed adjacent to GW12D in the northern portion of the TNT Manufacturing Area (Fig. 2.1-3). Analytical results revealed the presence of low levels of 2,4-DNT and 2,4,6-TNT (App. C). The ground water elevation and contaminant levels were consistent with the levels observed elsewhere in the TNT Manufacturing Area.

5.0 SUMMARY AND CONCLUSIONS

This section summarizes the principal findings of the supplemental RI and is organized by area of concern within the second operable unit. Contaminant sources are identified, and observed levels of contamination are indicated. Contaminant extent and migration potential are discussed.

5.1 ACIDS AREA/YELLOW WATER RESERVOIR

1. Contaminant sources were identified in the Phase I survey and include the sediments of the Yellow Water Reservoir and contaminated soil in the vicinity of the neutralization chamber.
2. Nitroaromatic contamination exists in the shallow aquifer. The contamination is limited in areal extent.
3. The gray clay confining layer is present at the Yellow Water Reservoir and acts as an effective barrier to vertical contaminant migration.
4. The contamination detected in the deep aquifer in April 1986 was attributed to shallow aquifer contamination being carried into the deep aquifer during drilling. The data obtained during the time-series sampling of GW27D and the resampling of GW36D confirmed this theory.
5. Ground water flow direction in the shallow aquifer is to the west; ground water flow in the deep aquifer is to the north.

5.2 RED WATER RESERVOIRS

1. The source strength of the sediments of Pond 1 and Pond 2 was refined through the sampling and analysis of deep sediment cores. Low levels of nitroaromatics were detected in several of the deeper sediment samples.
2. Nitroaromatic contamination was detected in the shallow ground water at Monitor Wells GW30, GW45, GW46, GW4[illegible] At SHW6, located at SR 62, the contamination is present at very low

levels (0.2 µg/L 2,4,6-TNT); the downgradient limit of contamination is projected to occur at or immediately west of SR 62.

3. The gray clay confining layer is present at the Red Water Reservoirs and acts as an effective barrier to vertical contaminant migration.
4. The apparent low-level contamination detected in the deep aquifer in 1986 is attributed to shallow contamination being carried into the deep aquifer during drilling. The data obtained during the time-series sampling of GW27D and the resampling of GW36D support this theory.
5. Ground water flow direction in the shallow aquifer is to the northwest; ground water flow in the deep aquifer is expected to have a northerly component.

5.3 POND 13/WET WELL AREA

1. The highest levels of nitroaromatics (principally 2,4,6-TNT) occur in the shallow aquifer downgradient of the Wet Well Area and red/yellow water trunk sewerline.
2. The contaminant plume appears to be confined to the immediate vicinity of the two wet wells at the Pond 13 area.
3. The shallow sand aquifer appears to be areally limited and is bounded by clay-dominant sediments observed at GW48D to the north and GW22D to the east.
4. The gray clay confining layer is present at Pond 13 and acts as an effective barrier to vertical migration.
5. Based on the water levels measured in the RI (ESE, 1986d) and supplemental RI (ESE, 1986a), essentially no direction of ground water flow can be established for the shallow aquifer.
6. The hydraulic head observed in the deep monitor wells is higher than those observed in the shallow aquifer, further substantiating the conclusion that vertical contaminant migration at Pond 13 is unlikely.

7. Although the substantial clay deposits below the contaminated shallow aquifer should constitute an effective barrier to downward contaminant migration, low levels of nitroaromatics were observed in the deep aquifer at GW48D.
8. The contamination observed at GW48D appears to be an isolated, localized occurrence.

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APPENDIX A--PHASE II
WELL DEVELOPMENT DATA

Table A-1. WVOW Monitor Well Development Data—Installation and Development Dates, Static Water Level, and Net Fluid Loss During Drilling

Well Designation	Dates*		Static Water Level†		Net Fluid Loss During Drilling (gal)
	Installation	Development	Before Development (ft)	After Development (ft)	
Phase I Monitor Wells					
GW1	Oct. 24-25	Nov. 8, 10	43.73	44.3	39
GW3	Oct. 25	Oct. 30	8.6	7.5	23
GW4	Oct. 21-22	Oct. 30	17.7	17.9	35
GW5	Nov. 26-27	Dec. 10-11	14.9	14.2	48
GW6	Nov. 6-7	Nov. 13	13.2	13.5	20
GW7	Oct. 29-31	Nov. 14	45.4	46.5	60
GW8	Oct. 29	Nov. 3-Dec. 13	19.1	18.4	30
GW9	Oct. 27	Oct. 31-Nov. 17	17.5	16.5	26
GW9D	Oct. 26-27	Oct. 31	26.4	27.0	37
GW10	Oct. 16	Oct. 21	22.1	21.8	20
GW10D	Oct. 15-16	Oct. 22, 24	32.6	32.4	55
GW11	Oct. 17	Oct. 25	27.1	27.0	28
GW12D	Oct. 19-21	Nov. 12-13	25.0	25.1	85
GW13	Oct. 21-22	Oct. 27	13.7	17.2	115
GW14	Oct. 19	Oct. 21	23.4	23.9	25
GW15	Nov. 13-14	Nov. 15	19.3	19.6	0
GW16	Oct. 24	Oct. 27-29	11.5	11.9	150
GW17	Oct. 24	Oct. 29-Dec. 14	16.3	16.4	0
GW18	Nov. 15	Nov. 16-17	7.9	7.7	70
GW19	Oct. 18	Oct. 24	24.3	24.3	31
GW20	Oct. 18	Oct. 31	31.3	31.2	33
GW21	Oct. 25	Oct. 30-Nov. 26	8.8	10.6	100
GW21D	Nov. 7-8	Nov. 8-11	Flowing	Flowing	50
GW22	Oct. 13-14	Oct. 19	1.7	1.6	47
GW22D	Oct. 8, 12	Oct. 17, 21	Flowing	Flowing	40
GW23S	Oct. 30	Nov. 6	5.7	5.8	25
GW23I	Oct. 30-31	Nov. 5-6	6.8	6.4	70
GW24	Nov. 1	Nov. 5	13.1	13.2	60
GW25	Nov. 11	Nov. 14	20.4	20.6	18
GW25D	Nov. 8, 11	Nov. 14	38.9	39.4	26
GW26	Nov. 2	Nov. 5	17.5	17.5	0
GW27	Oct. 20-21	Oct. 25	14.3	14.5	325
GW28	Nov. 2	Nov. 7	12.8	12.9	65
GW29	Oct. 16-17	Oct. 26	38.1	38.1	150
GW30	Oct. 18	Oct. 26	32.2	32.2	0
GW31	Oct. 17-18	Oct. 26	33.8	33.8	200
GW32	Oct. 19-20	Oct. 27-Dec. 20	10.2	11.80	300

Table A-1. WVOW Monitor Well Development Data—Installation and Development Dates, Static Water Level, and Net Fluid Loss During Drilling (Continued, Page 2 of 2)

Well Designation	Dates* Installation	Dates* Development	Static Water Level† Before Development (ft)	Static Water Level† After Development (ft)	Net Fluid Loss During Drilling (gal)
Phase I Monitor Wells (Continued)					
GW32D	Nov. 29-30	Dec. 11	14.2	13.6	34
GW33	Dec. 1	Dec. 12-20	10.3	9.3	5
GW34	Nov. 14	Nov. 16	21.0	20.2	125
GW34D	Nov. 12, 14	Nov. 16	28.3	32.0	60
GW35	Oct. 31-Nov. 1	Nov. 8-11	2.9	3.6	200
GW36D	Nov. 27, 29	Dec. 11	30.8	20.4	54
GW37	Nov. 12-13	Nov. 15-Dec. 20	25.4	24.8	75
GW38	Nov. 5-6	Nov. 9-Dec. 14	3.2	1.9	125
GW39	Nov. 6-7	Nov. 13-15	3.3	4.1	75
GW40	Nov. 16	Nov. 18	26.4	26.8	70
GW40D	Nov. 16-17	Nov. 18	27.0	28.1	0
GW41	Nov. 3	Nov. 7	14.0	14.0	75
GW42	Nov. 8	Nov. 15	17.8	15.5	75
Phase II Monitor Wells					
GW27D	Mar. 30-Apr. 1	Apr. 3	16.4	17.0	324
GW43	Mar. 12	Mar. 19	20.0	20.1	44
GW44	Apr. 2	Apr. 4	14.0	14.0	50
GW45	Mar. 16-17	Mar. 20	42.5	42.5	69
GW45D	Mar. 13-16	Mar. 20	45.6	46.6	169
GW46	Mar. 17-18	Mar. 20	42.1	42.2	70
GW47	Apr. 2-3	Apr. 5	49.9	50.4	80
GW48D	Mar. 21-23	Mar. 25	7.3	7.3	218
GW49	Mar. 18-19	Mar. 21	8.6	8.7	85

*Phase I wells were installed and developed in 1984; Phase II wells were installed and developed in 1986.
†Water levels measured from top of casing.

Sources: ESE, 1986a, d.

AR304678

Table A-2. WVOW Monitor Well Development Data—Fluid in Well Prior to Development, Well Depth, Screen Length, and Stickup

Well Designation	Fluid in Well Prior to Development (gal)		Well Depth—Top of Casing to Bottom of Screen (ft)	Screen Length (ft)	Well Depth—Top of Casing to Top of Sediment (ft)		Stickup (ft)
	Casing	Annulus			Before	After	
Phase 1 Monitor Wells							
GW1	39.0	9.0	92.2	15.0	91.2	92.2	2.5
GW3	14.5	15.4	31.0	15.0	29.9	30.8	2.5
GW4	20.2	15.4	48.7	15.0	48.6	48.7	2.15
GW5	34.5	21.6	69.4	14.5	63.6	69.0	2.4
GW6	21.7	25.7	46.3	15.0	46.2	46.3	2.5
GW7	28.5	20.5	89.5	15.0	87.6	89.7*	2.5
GW8	12.0	19.0	31.7	15.0	30.75	31.7	2.5
GW9	9.0	9.0	36.5	15.0	36.1	36.2	2.3
GW9D	38	15.4	85.0	15.0	85.0	85.0	2.3
GW10	12	7.6	33.8	15.0	33.3	33.6	2.2
GW10D	39	15.4	92.4	15.0	91.2	91.5	2.5
GW11	9.0	12.0	39.5	15.0	39.5	39.5	2.5
GW12D	48.0	10.0	97.0	15.0	91.9	97.1*	2.5
GW13	18.8	29.6	42.5	15.0	41.2	42.1	2.5
GW14	11.9	7.6	35.0	15.0	34.8	34.9	2.6
GW15	4.8	15.4	26.6	10.0	26.7	26.5	2.6
GW16	4.1	7.7	17.8	5.0	17.4	17.4	2.5
GW17	9.0	14.2	29.5	15.0	28.6	29.1	2.5
GW18	5.6	15.4	16.6	10.0	16.3	16.8*	2.6
GW19	6.5	9.0	34.0	15.0	33.7	33.7	2.5
GW20	8.4	9.0	40.3	15.0	40.4	40.4*	2.5
GW21	7.8	8.4	28.2	10.0	27.9	29.0†	2.5
GW21D	40.8	20.6	62.2	15.0	62.3	62.4*	2.5
GW22	46	15.4	73.1	15.0	68.6	72.2	2.5
GW22D	70	15.4	108.3	15.0	106.8	106.9	2.5
GW23S	37	58.3	17.0	10.0	16.3	17.0	2.5
GW23I	66	104	27.0	15.0	25.5	26.8	2.5
GW24	43.5	68.5	26.5	15.0	26.5	26.6*	2.5
GW25	7.0	20.6	31.5	15.0	31.1	31.2	2.5
GW25D	15.0	21.6	62.5	15.0	61.8	61.9	2.5
GW26	4.9	26.0	25.5	10.0	25.4	25.2	2.5
GW27	17.4	15	41.0	15.0	40.5	40.8	2.5
GW28	44.7	70.5	26.5	15.0	26.1	26.2	2.5
GW29	6.4	10.0	47.9	15.0	46.8	47.7	2.5
GW30	4.0	7.0	38.0	10.0	37.8	37.8	2.5
GW31	9.8	15.4	49.0	20.0	48.9	48.9	2.5
GW32	19.8	26.8	40.5	15.0	39.3	40.4	2.5

Table A-2. WVOW Monitor Well Development Data—Fluid in Well Prior to Development, Well Depth, Screen Length, and Stickup (Continued, Page 2 of 2)

Well Designation	Fluid in Well Prior to Development (gal) Casing	Annulus	Well Depth—Top of Casing to Bottom of Screen (ft)	Screen Length (ft)	Well Depth—Top of Casing to Top of Sediment (ft) Before	After	Stickup (ft)
Phase I Monitor Wells (Continued)							
GW32D	35.4	20.0	68.5	15.0	67.5	68.2	2.5
GW33	9.6	15.0	25.0	15.0	25.0	24.8	2.5
GW34	9.8	20.4	37.0	20.0	36.0	36.9	2.5
GW34D	60.5	25.7	116.5	15.0	120.9	115.3	2.5
GW35	28.8	45.3	47.0	15.0	46.2	47.5†	2.5
GW36D	40.5	20.1	95.0	15.0	91.2	94.6	2.2
GW37	6.3	15.4	35.0	10.0	32.8	34.4	2.5
GW38	20.8	20.6	35.0	15.0	33.4	34.8	2.5
GW39	25.7	18.9	32.5	20.0	31.5	32.2	2.5
GW40	8.8	20.1	39.9	15.0	39.6	39.8	2.6
GW40D	43.0	26.0	93.0	20.0	88.8	91.4	2.5
GW41	47.2	74.4	28.5	15.0	28.4	28.5	2.5
GW42	6.0	20.6	26.8	15.0	27.3*	27.0*	2.5
EPA01**	NA	NA	13.0	5.0	NA	NA	3.92
EPA02	NA	NA	10.5	5.0	NA	NA	3.50
EPA03	NA	NA	12.33	5.0	NA	NA	3.00
EPA04	NA	NA	24.0	5.0	NA	NA	4.00
Phase II Monitor Wells							
GW27D	57.2	13.5	104.7	15.0	102.8	102.8	2.2
GW43	12.2	11.0	37.2	15.0	37.2	37.2	2.2
GW44	15.0	11.8	37.2	15.0	37.0	37.1	2.2
GW45	9.9	9.0	57.2	15.0	56.6	57.3	2.2
GW45D	40.3	13.6	108.2	15.0	107.4	107.4	2.2
GW46	9.9	8.9	57.2	15.0	56.8	57.1	2.2
GW47	10.4	9.4	66.2	15.0	65.8	66.1	2.2
GW48D	65.4	17.0	109.2	20.0	107.5	107.7	2.2
GW49	18.0	12.7	36.2	15.0	35.9	36.1	2.2

* Measurement errors of $\leq$0.2 ft due to difficulty in sounding wells to determine sediment thickness.
† Probable measurement error by field personnel.
**EPA well construction details are included for comparison purposes.
NA = Not applicable.

Sources: ESE, 1986a, d.

AR304680

Table A-3. WVOW Monitor Well Development Data—Required Volume, Quantity Removed, Time for Removal, Type of Pump Used for Development, and Physical Characteristics of Water Before and After Development

Well Designation	Required Volume (gal)	Quantity Removed (gal)	Time for Removal	Type of Pump Used for Development	Physical Characteristics of Water: Before Development	Physical Characteristics of Water: After Development
GW1	435	1,641	3.2 hr	Submersible	Turbid/red silty solids	Slightly turbid/red sility solids
GW3	210	320	1.1 hr	Centrifugal	Turbid/red-brown suspended solids	Clear
GW4	353	375	1.3 hr	Submersible	Turbid/gray suspended solids and sediment	Slight turbidity/trace suspended solids
GW5	520	608	1.4 hr	Submersible/Centrifugal	Very turbid/gray silty suspended solids	Slight turbidity/gray silty solids
GW6	337	374	2.0 hr	Submersible	Turbid/brown silty suspended solids	Clear/trace suspended solids
GW7	545	823	3.4 hr	Submersible	Turbid/gray silty solids	Clear/fine gray silty solids
GW8	305	300	8 days	Centrifugal	Turbid/light brown silty suspended solids	Clear
GW9	220	226	6 days	Centrifugal/Submersible	Very turbid/light gray suspended solids	Turbid/gray suspended solids
GW9D	452	632	1.3 hr	Submersible	Very turbid/gray suspended solids	Less turbid/gray suspended solids
GW10	198	300	1 hr	Centrifugal	Very turbid/red-brown suspended solids	Clear/slight red-brown suspended solids
GW10D	547	920	2.0 days	Submersible	Very turbid/gray suspended solids	Less turbid/gray suspended solids
GW11	245	920	1.9 hr	Submersible	Very turbid/red-brown suspended solids	Clear/slight red-brown suspended solids
GW12D	715	1,008	2.0 days	Submersible	Very turbid/red-gray silty solids	Clear
GW13	817	840	2.5 hr	Submersible	Highly turbid/brown very silty solids	Clear
GW14	222	250	1 hr	Centrifugal	Very turbid/red-brown suspended solids	Clear/trace of red-brown settleables
GW15	101	231	1.2 hr	Submersible	Very turbid/red-suspended solids	Clear
GW16	810	820	3 days	Submersible	Very turbid/yellow-brown silty solids	Clear

AR304681

Table A-3. WVOW Monitor Well Development Data—Required Volume, Quantity Removed, Time for Removal, Type of Pump Used for Development, and Physical Characteristics of Water Before and After Development (Continued, Page 2 of 4)

Well Designation	Required Volume (gal)	Quantity Removed (gal)	Time for Removal	Type of Pump Used for Development	Physical Characteristics of Water: Before Development	Physical Characteristics of Water: After Development
GW17	492	495	27 days	Centrifugal	Very turbid, dark brown, silty	Clear
GW18	455	455	2.0 days	Centrifugal	Very turbid/red silty suspended solids	Clear
GW19	235	525	1.8 hr	Centrifugal	Very turbid/red-brown suspended solids	Clear/no visible solids
GW20	250	530	1.3 hr	Submersible	Very turbid/red-brown suspended solids	Clear
GW21	397	314	14 days	Centrifugal	Very turbid/gray suspended solids	Slightly turbid/gray suspended solids
GW21D	557	2,440	3 days	Centrifugal	Turbid/gray-brown suspended solids	Slightly turbid/gray-brown fines
GW22	542	570	3.0 hr	Submersible	Very turbid/gray suspended solids	Clear
GW22D	627	2,120	2 days	Centrifugal	Very turbid/gray suspended solids	Clear/slight gray suspended solids
GW23S	220	323	0.5 hr	Centrifugal	Very turbid/red-gray suspended solids	Clear
GW23I	551	680	1.8 hr	Centrifugal	Very turbid/gray suspended solids	Clear
GW24	412	440	0.8 hr	Centrifugal	Very turbid/red suspended solids	Clear
GW25	230	480	1 hr	Submersible	Very turbid/red suspended solids	Clear/slight red suspended solids
GW25D	313	623	1.4 hr	Submersible	Very turbid/red suspended solids	Clear
GW26	39	198	0.5 hr	Centrifugal	Very turbid/red suspended solids	Clear
GW27	1,787	2,340	2.0 hr	Centrifugal	Very turbid/red-brown suspended solids	Clear/slight yellow tint to water
GW28	440	509	0.9 hr	Centrifugal	Very turbid/red-gray suspended solids	Slight cloudy [illegible]
GW29	832	900	1.5 hr	Submersible	Turbid/brown silty solids	Slightly turbid/yellow-brown solids

Table A-3. WVOW Monitor Well Development Data—Required Volume, Quantity Removed, Time for Removal, Type of Pump Used for Development, and Physical Characteristics of Water Before and After Development (Continued, Page 3 of 4)

Well Designation	Required Volume (gal)	Quantity Removed (gal)	Time for Removal	Type of Pump Used for Development	Physical Characteristics of Water: Before Development	Physical Characteristics of Water: After Development
GW30	55	300	1.0 hr	Submersible	Very turbid/brown silty solids; sand	Slightly turbid/ light yellow
GW31	1,126	1,200	2.0 hr	Submersible	Very turbid/brown silty solids	Slightly turbid/ brown silty solids
GW32	1,740	1,197	22 days	Centrifugal	Turbid/slight brown suspended solids	Clear
GW32D	448	800	1.5 hr	Submersible	Turbid/gray suspended solids	Clear to gray-cloudy
GW33	148	149	5 days	Centrifugal	Turbid/red silty suspended solids	Slight silty suspended solids
GW34	776	927	1.7 hr	Submersible	Turbid/brown silty suspended solids	Clear
GW34D	735	832	3.5 hr	Submersible	Very turbid/brown silty suspended solids	Slightly turbid/ brown suspended solids
GW35	1,245	1,300	3.0 days	Centrifugal	Very turbid/gray suspended solids and sediments	Clear
GW36D	573	805	1.9 hr	Submersible	Very turbid/gray-brown silty solids	Slightly turbid/ gray-brown solids
GW37	290	290	11 days	Submersible	Turbid/gray suspended solids	Gray suspended solids
GW38	832	840	12 days	Centrifugal	Turbid/gray suspended solids	Clear
GW39	598	865	2 days	Centrifugal	Turbid/brown silty solids	Clear
GW40	495	855	1.6 hr	Submersible	Very turbid/red suspended solids	Clear
GW40D	573	769	8.0 hr	Submersible	Very turbid/gray silty suspended solids	Clear/light turbid gray silt
GW41	497	840	1.0 hr	Centrifugal	Very turbid/red suspended solids and sediment	Clear
GW42	510	936	1.8 hr	Submersible	Very turbid/red suspended solids	Clear/slight red silty residue

AR304683

Table A-3. WVOW Monitor Well Development Data—Required Volume, Quantity Removed, Time for Removal, Type of Pump Used for Development, and Physical Characteristics of Water Before and After Development (Continued, Page 4 of 4)

Well Designation	Required Volume (gal)	Quantity Removed (gal)	Time for Removal	Type of Pump Used for Development	Physical Characteristics of Water: Before Development	Physical Characteristics of Water: After Development
27D	2,447	3,945	8.8 hr	Submersible	Turbid, organge color, heavy suspended solids.	Clear
43	336	368	55 min	Centrifugal	Turbid, strong brown, heavy suspended solids.	Very slight suspended solids, clear.
44	383	384	1.1 hr	Centrifugal	Turbid, strong brown, moderate suspended solids.	Very slight suspended solids, clear.
45	440	510	51 min	Submersible	Turbid, strong brown, heavy suspended solids.	Very low suspended solids, yellowish color.
45D	871	1,060	1.8 hr	Submersible	Turbid, very heavy suspended solids, dark gray.	Very low suspended solids, clear.
46	444	600	1.0 hr.	Submersible	Turbid, heavy suspended solids, strong brown.	Slight turbidity, strong brown, moderate suspended solids.
47	334	494	1.1 hr	Submersible	Turbid, heavy suspended solids, orange.	Slight turbidity, yellowish color.
48D	797	1,495	5 hr	Submersible	Turbid, dark gray to brown, heavy suspended solids.	Slight turbidity, yellow suspended solids.
49	578	848	1.8 hr	Centrifugal	Ver turbid, heavy suspended solids, strong brown.	Very slight turbidity, very low suspended solids.

Sources: ESE, 1986a, d.

AR304684

Table A-4. WVCW Monitor Well Development Data—Temperature, Conductivity, and pH

Well Designation	Temperature (°C) Before*	During*		After*	Conductivity (μmhos/cm) Before*	During*		After*	pH Before*	During*		After*
Phase I Monitor Wells												
GW1	12.9	13.5	13.2	13.0	456	477	449	426	9.0	8.1	7.0	6.9
GW3	13.7	13.4	13.4	13.3	940	1,390	1,497	1,519	7.2	6.9	7.0	6.9
GW4	13.3	13.4	13.1	13.1	697	1,051	1,162	1,125	7.4	6.7	6.7	6.7
GW5	13.0	13.8	14.1	13.4	253	221	219	221	9.0	7.7	7.7	7.5
GW6	11.6	13.1	11.2	12.8	461	433	431	439	7.2	6.9	7.0	7.0
GW7	12.9	13.4	13.1	13.7	614	636	588	528	12.5	7.6	7.2	7.2
GW8	12.5	12.7	14.4	15.7	594	621	578	560	6.9	7.2	7.3	7.0
GW9	14.1	13.0	12.5	11.9	527	822	790	772	7.3	6.7	6.9	7.1
GW9D	13.0	12.8	12.8	12.9	263	252	251	250	8.2	7.5	7.5	7.4
GW10	14.9	14.3	13.8	14.2	355	246	226	208	7.8	7.3	6.0	5.6
GW10D	13.9	13.7	13.3	13.1	12,870	278	277	270	12.3	9.4	8.5	8.1
GW11	13.4	12.7	12.8	12.6	176	156	154	154	6.1	5.7	5.5	5.4
GW12D	12.2	12.6	11.7	12.8	446	287	239	234	10.5	10.0	9.4	9.[illegible]
GW13	13.5	12.9	13.0	13.0	245	153	135	139	7.5	5.9	5.9	[illegible]
GW14	15.1	15.0	15.1	15.0	355	195	187	193	6.6	6.6	5.6	5.6
GW15	12.4	13.1	13.1	13.0	237	187	187	185	5.7	4.8	5.4	5.3
GW16	17.0	15.0	16.0	15.0	250	162	161	161	6.6	5.5	5.3	5.0
GW17	15.0	14.2	15.1	16.5	223	81	176	255	6.5	6.3	5.6	5.8
GW18	13.4	13.7	14.6	14.9	271	101	101	99	6.5	6.5	5.5	5.8
GW19	15.0	14.1	13.9	13.7	303	293	269	262	6.0	5.8	6.1	5.5
GW20	13.0	12.6	12.5	12.6	181	138	130	136	5.7	5.4	5.4	5.4
GW21	14.2	13.2	17.5	15.3	483	573	537	330	6.7	6.9	7.2	6.8
GW21D	12.0	12.1	11.9	12.5	200	200	202	211	6.6	6.1	6.3	6.4
GW22	14.7	14.5	14.4	13.6	295	238	199	205	9.3	8.8	8.3	7.9
GW22D	18.2	14.1	14.1	15.2	2,280	184	181	178	11.2	8.3	7.3	6.8
GW23S	14.6	15.5	15.6	15.6	152	172	164	158	5.9	5.8	5.7	5.7
GW23I	14.4	16.5	17.0	16.9	377	202	155	138	6.6	5.8	5.6	5.4
GW24	†	†	†	†	230	64	56	49	6.2	5.6	5.3	5.2
GW25	12.3	12.5	12.5	12.5	333	81	67	60	8.7	7.4	5.7	5.5
GW25D	12.6	12.6	12.6	12.4	238	102	92	88	6.9	6.2	5.9	5.7
GW26	14.1	13.9	13.8	13.6	112	53	41	39	5.5	5.1	5.1	5.1
GW27	14.8	13.6	13.5	13.3	181	145	142	141	5.8	5.3	5.1	5.1
GW28	13.3	13.4	13.4	13.4	96	69	58	61	5.5	5.1	5.1	5.0
GW29	16.0	14.0	14.0	14.0	310	247	250	240	5.6	6.3	6.4	6.5
GW30	15.0	13.3	13.0	13.0	230	151	154	162	6.4	6.1	5.6	5.6
GW31	15.0	14.0	13.7	14.0	240	170	170	168	6.8	6.5	5.7	[illegible]
GW32	12.7	14.9	13.7	12.9	404	419	256	308	6.6	[illegible]	[illegible]	[illegible]
GW32D	11.6	11.8	12.2	12.0	2,460	220	205	195	13.8	8.4	7.0	6.8
GW33	13.6	†	14.9	12.0	630	†	579	537	7.1	†	7.1	7.0
GW34	11.7	11.9	11.9	†	168	300	351	†	6.4	5.7	5.8	

AR304685

Table A-4. WVOW Monitor Well Development Data—Temperature, Conductivity, and pH (Continued, Page 2 of 2)

Well Designation	Temperature (°C) Before*	During*		After*	Conductivity (µmhos/cm) Before*	During*		After*	pH Before*	During*		After*
Phase I Monitor Wells (Continued)												
GW34D	12.9	12.5	12.8	12.9	572	258	245	227	7.5	7.0	7.1	7.0
GW35	12.7	12.3	12.1	12.3	419	312	307	306	6.6	7.3	7.1	7.0
GW36D	12.7	12.9	13.0	12.8	5,500	302	245	229	12.4	9.6	8.3	7.4
GW37	12.8	11.3	12.5	12.3	339	361	364	391	6.4	5.8	5.9	5.9
GW38	13.5	13.4	14.1	18.1	345	321	286	244	6.7	6.8	7.5	7.1
GW39	14.4	14.1	14.2	13.9	278	283	290	286	5.9	5.8	6.6	6.3
GW40	12.0	12.5	12.4	12.7	222	201	201	200	-2.0	5.0	3.9	5.6
GW40D	12.9	12.1	13.5	†	269	169	225	†	11.5	†	7.7	†
GW41	16.6	17.0	13.9	13.9	232	194	192	190	5.5	5.1	5.1	5.0
GW42	12.9	12.5	12.7	12.6	283	63	55	49	6.1	5.9	5.4	5.4
Phase II Monitor Wells												
GW27D	18.5	20.0	19.0	19.0	325	145	140	135	10.8	6.8	6.1	6.2
GW43	14.5	13.8	14.7	14.3	088	073	075	074	5.9	5.3	5.3	5.2
GW44	18.0	18.0	18.0	18.0	285	125	090	100	10.0	7.5	6.6	6.8
GW45**	10.5	9.0	8.0	9.0	220	195	180	180	6.7	6.4	6.1	6.1
GW45D	12.0	12.0	13.0	13.0	475	230	225	215	9.8	7.7	7.5	7.2
GW46	0††	12.6	12.4	12.0	602	342	333	330	7.6	6.9	6.9	6.6
GW47	18.0	18.0	16.5	17.0	370	345	345	340	7.2	7.4	7.0	7.4
GW48D	14.0	14.5	16.0	175	125	130	130	130	7.3	6.9	6.9	7.0
GW49	10.0	10.0	11.0	11.0	075	075	055	050	6.0	6.2	6.0	6.2

*Stage of development.
†Not measured.
**Temperature readings suspect. Air temperature was -2°C, discharge was cooled as water passed through approximately 50 ft of hose at surface.
††Probe malfunction.

Sources: ESE 1986a, d.

AR304686

APPENDIX B--PHASE II

WELL LOGS

NOTE: Copies in this appendix are the best quality available.

AR304688

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	TOP OF BERM EASTERN SIDE OF YELLOW WATER RESERVOIR.
Water Level	FIRST WATER: 14'
Time	0935
Date	3/25/86

Boring No. 27D-I Date 3/25/86 Sheet 1 of [illegible]

Type of Boring [illegible] Rig [illegible]

Casing used PVC Size 4" Drilling mud used NONE

Boring begun 3/25/86 Boring completed 3/27/86 [illegible]

Ground Elevation ______ referred to ______ Datum

Field Party: R. HARLAST; [illegible]; JEFF AUSTIN

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		CLAY W/ LITTLE SAND ~10%; DK. BROWN; HIGHLY PLASTIC; SOFT; MOIST; ALLUVIUM.
									FAT CLAY W/ [illegible] SAND [illegible] SILT; 10YR 4/6 - BROWN TO DK. BROWN; HIGHLY PLASTIC; STIFF; V. SLIGHTLY MOIST; NAR; ALLUVIUM
	1	5-6.5'			1.0'	CH	5		
									SANDY-CLAY AT TOP W/ [illegible] FINE SAND [illegible] CLAY GRADING INTO A CLAYEY-SAND AT BOTTOM W/ [illegible] CLAY [illegible] FINE SAND; 7.5YR 4/6 - BROWN; HIGHLY PLASTIC TOP TO LOW PLASTICITY BOTTOM; STIFF TOP TO LOOSE BOTTOM SAND; V. SLIGHTLY MOIST; NAR; ALLUVIUM.
						CL	10		
	2	10-11.5'			1.5'	SP-SC			
									POORLY GRADED FINE SAND W/ ~5% CLAY; 10YR 5/6 - YELLOWISH BROWN; NON PLASTIC; LOOSE; WET; NAR; ALLUVIUM.
	3	15-16.5'			1.2'	SP	15		
									POORLY GRADED FINE SAND W/ ~5% CLAY; 10YR 4/6 - DK. YELLOWISH BROWN; NON PLASTIC; LOOSE; WET; NAR; ALLUVIUM.
	4	20-21.5'			1.0'	SP	20		

FIRST WATER @ ~14' SAMP. WR

AR304689

Signed Robert C. Harlast Date 3/25/86

Approved [illegible] Date 4/20

AAAP 10/4/80

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 22D Date 3/25/86 Sheet 2 of 3

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______

______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									Well graded fine to med. sands w/ ~15% silt, 10% clay, <20% fine to coarse gravel, well rounded; 10YR 4/4 - dk yellow brown; non-plastic; loose, wet; two 1/2" black streaks at ~26' may be organic; alluvium.
	5	25-26.5'			1.2'	SW-SM	25		
									Poorly graded fine sand w/ ~5% silt or clay; 10YR 4/6 - dk yellow brown; non plastic; loose; wet; 1/4" black streaks [illegible] at ~31'; alluvium.
	6	30-31.5'			1.5'	SP	30		
									Poorly graded fine sand w/ ~7% silt or clay; 10YR 4/4 - dk yellow brown; not plastic; loose; wet; sand is graded w/ red brown sand in bottom of sample & bottom 2" of sample is clayey sand w/ ~20% silt or clay; alluvium
	7	35-36.5'			1.0'	SP	35		
						SC			
									Poorly graded fine sand w/ ~5% clay or silt; 10YR 3/4 - dk yellowish brown; non plastic; loose; wet; grades into ~20% black [illegible] [illegible] AB304690. [illegible], alluvium.
	8	40-41.5'			1.2'	SP	40		

Signed [signature] Date 3/25/86

B-2 Approved [initials] AB304690 Date 4/20

AAAP 10/4/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 27D Date 3/25/86 Sheet 3 of [illegible]

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	9	45-46.5			1.2'	SP	45		POORLY GRADED FINE SAND W/~5% SILT OR CLAY; 10YR 4/6 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; RANGES AND BROWN AND NUMEROUS BLACK STREAKS IN BOTTOM 2" OF SAMPLE; ALLUVIUM.
	10	50-51.5'			1.5'	SW	50		POORLY GRADED FINE SANDS, SOME AT ABOVE AT TOP, GRADING INTO A WELL GRADED GRAVELLY SAND AT BOTTOM W/~15% SILT OR CLAY AND ~30% FINE GRAVEL WAS ROUNDED IN FINE & MED. SAND; 10YR 4/4 - DK YELLOW BROWN W/~3" LAYER OF 10YR 4/6 AT ~51'; NOT PLASTIC; LOOSE; WET; SOME GRAY STRINGERS OR LENSES IN BOTTOM OF SAMPLER; ALLUVIUM.
	11	55-56.5'			1.5	CH	55		FAT CLAY W/NO SAND OR SILT; 5Y 4/1 - DK GRAY; HIGHLY PLASTIC; STIFF; V. SLIGHTLY MOIST; NAB; ALLUVIUM.
	12	60-61.5'			1.5'	CH	60		FAT, MICACEOUS CLAY W/NO SAND OR SILT; 5Y 4/1 - DK GRAY; HIGHLY PLASTIC; STIFF; V. SLIGHTLY MOIST; NAB; ALLUVIUM.

AR300591

Signed [illegible signature] Date 3/26/86

B-3

Approved DLK Date 4/20

AAAP 10/488

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client U S ATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 27D Date [illegible] Sheet 1 of 1

Type of Boring ____ Rig ____

Casing used ____ Size ____ Drilling mud used ____

Boring begun ____ Boring completed ____

Ground Elevation ____ referred to ____ Datum

Field Party: ____

Depth of Casing, Ft.	Sample No.	Sample Depth From-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	13	65-66.5'			1.5'	CH	65		[illegible]
	14	70-71.5'			1.5'	CH	70		[illegible]
						CL			[illegible]
	15	75-76.5'			1.5'	CL	75		[illegible]
	16	[illegible]			1.5'	[illegible]	80		[illegible]

AR300692

Signed [illegible] Date [illegible]

B-4

Approved DLK Date 4/20

AAAP 10/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. [illegible]

Client [illegible]

Project [illegible]

Boring No. [illegible] Date [illegible] Sheet 5 of [illegible]

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Location of Boring:	
Water Level	
Time	
Date	

Depth of Casing Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	17	35-36.5'				SM	35		[illegible]
	18	40-41.5'			[illegible]	[illegible]	40		[illegible]
	19	45-46.5'			10"	CL	45		[illegible]
	20	100-101.5'				SM	100		[illegible]

AR304693

Signed [illegible] Date [illegible]

B-5

Approved DLK Date 4/20

Site WVDW
Boring No. GW-27D

SHEET ___ OF ___

WATER USED (GAL)

3/25/86

0815 - ARRIVED AT SITE - POSITIONED RIG + BEGAN SET-UP TO START DRILLING

0900 - BEGAN DRILLING TO 5' / DROVE TEMPORARY 8" CASING TO / BAILED HOLE +10/-10

0915 - DROVE SAMPLE 5-6.5'

0917 - DRILLED TO 10' / DROVE CASING TO 10' / BAILED HOLE +10/-10

0922 - DROVE SAMPLE 10-11.5'

0925 - DRILLED TO 15' / BAILED HOLE +5/-20

0934 - DROVE SAMPLE 15-16.5'

0936 - PULLED OUT TEMPORARY 8" CASING / DROVE "PERMANENT" 8" CASING TO 18'

0952 - DRILLED HOLE TO 20' / BAILED HOLE +10/-30

1005 - DROVE SAMPLE 20-21.5'

1008 - ADDED CASING (8") / DROVE CASING TO 25'

1020 - DRILLED TO 25' / BAILED HOLE +5/-20

1024 - DROVE SAMPLE 25-26.5'

1027 - ADDED 8" CASING / DROVE CASING TO 35'

1035 - DRILLED TO 30' / BAILED HOLE +4/-30

1042 - DROVE SAMPLE 30-31.5'

1045 - DRILLED TO 35' / BAILED HOLE +4/-20

1049 - DROVE SAMPLE 35-36.5'

1052 - ADDED CASING / DROVE CASING TO 40'

1059 - DRILLED TO 40' / BAILED HOLE +0/-40

1108 - DROVE SAMPLE 40-41.5'

1111 - ADDED CASING / DROVE CASING TO

1118 - DRILLED TO 45' / BAILED HOLE +8/-40

1129 - DROVE SAMPLE 45-46.5'

1132 - ADDED CASING / DROVE CASING TO 50'

1145 - DRILLED TO 50' / BAILED HOLE +3/-40

1155 - DROVE SAMPLE 50-51.5'

1158 - DROVE CASING TO 55' / DRILLED TO 55' / BAILED HOLE +4/-40

1213 - DROVE SAMPLE 55-56.5'

1225 - BROKE FOR LUNCH

1240 - BAILED HOLE -20

3/25/86 — DATE

Robert C. [illegible] — SIGNED

[illegible] 4/2 — APPROVED

AR304694

Site WVOW
Boring No GW-27-D I

SHEET 7 OF [illegible]

1243 - DROVE HOLE TO 60' / BAILED HOLE +0/-40
1254 - DROVE SAMPLE 60-61.5'
1257 - DRILLED HOLE TO 61.5' / BAILED HOLE +9/-20
1305 - ADDED CASING - WELDED JOINT / DROVE CASING TO 62'
1325 - SHUT DOWN RIG - ACCORDING TO INSTRUCTIONS, ONCE CLAY LAYER IS BREACHED, WELL MUST BE DRILLED + INSTALLED IN SAME DAY TO MINIMIZE CONTAMINATION OF LOWER AQUIFER THRU HOLE - NOT ENOUGH TIME LEFT TO COMPLETE WELL TODAY SO WILL FINISH TOMORROW - CLAY HIT AT 54' + STILL CLAY AT 62'
1330 - WENT TO FILL WATER TANK
1415 - RETURNED W/WATER - LEFT SITE FOR DAY
3/21/86
0715 - ARRIVE AT SITE - [illegible] DRILL
0730 - DRILLED TO 65' / BAILED HOLE +22/-50
0742 - DROVE CASING TO 65' / DRILLED TO 65' / BAILED HOLE [illegible]
0758 - DROVE SAMPLE 65-66.5'
0801 - DRILLED TO 70' / BAILED HOLE [illegible]
[illegible] - DROVE SAMPLE [illegible]
0820 - DROVE CASING TO 75' / DRILLED TO 75' / BAILED HOLE [illegible]
0831 - DROVE SAMPLE 75-76.5'
0834 - DRILLED TO 80' / BAILED HOLE [illegible]
0840 - ADDED CASING - WELDED JOINT / DROVE [illegible] 80'
[illegible]
[illegible]
[illegible]
0930 - DRILLED HOLE TO [illegible] / BAILED HOLE [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

AR304695

[illegible] DATE

[illegible] SIGNED

DLK 4/20 APPROVED

Site [illegible]
Boring No. [illegible]-37 [illegible] E

SHEET [illegible] OF [illegible]

[illegible]

1105 - [illegible] casing to 100'
1112 - Drilled to 100' / [illegible] [illegible] +0'/-70
1127 - [illegible] sample 100-101.5'
1135 - [illegible]
1152 - [illegible] out hole [illegible] to [illegible] 100' -70
1205 - [illegible] w/ [illegible]
[illegible] w/ Bottom Plug, then 40'
[illegible]
1218 - [illegible]
[illegible] PVC BACK out [illegible] dirty water [illegible] out of hole
1228 - [illegible] +35/-70
[illegible] = Bottom at [illegible]
[illegible] 4½ [illegible]
1255 [illegible]
1300 - [illegible]
[illegible]
[illegible] Bottom [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
1400 - [illegible]
[illegible]
[illegible]
1501 - [illegible]
[illegible]
[illegible]
[illegible]
[illegible] casing [illegible]
1600 - [illegible] day

3/26/[illegible]
DATE

[illegible] AB304696
SIGNED

[illegible] 4/[illegible]
APPROVED BY

Site WVCW

Boring No. [illegible] 27 D

SHEET 9 OF 9

3/27/86

0735 - ARRIVED AT SITE - [illegible]
[illegible] 4" CASING [illegible]
[illegible]

0810 - MIXED TUB GROUT USING 3 BAGS [illegible]

0820 - POURED GROUT

0825 - MIXED 2ND TUB GROUT SAME MIX / POURED GROUT

0835 - MIXED 3RD TUB GROUT - SAME MIX / PULLED 8" CASING TO 63' / WASHED CASING - CUT + REMOVED PIECE / POURED GROUT

0850 - MIXED 4TH TUB GROUT - SAME MIX / POURED GROUT

0900 - MIXED 5TH TUB GROUT - SAME MIX / POURED GROUT

0915 - MIXED 6TH TUB GROUT - SAME MIX / POURED GROUT

0930 - PULLED CASING TO 53' / WASHED CASING - CUT + REMOVED PIECE

0945 - MIXED 7TH TUB GROUT - SAME MIX / POURED GROUT

0955 - MIXED 8TH TUB GROUT - SAME MIX / PULLED CASING TO 43' / WASHED CASING - CUT + REMOVED PIECE / POURED GROUT

1010 - MIXED 9TH TUB GROUT - SAME MIX / PULLED CASING TO 33' / WASHED CASING - CUT + REMOVED PIECE / POURED GROUT

1025 - PULLED CASING TO 30' / WASHED CASING + CUT + REMOVED PIECE

1035 - RAN OUT OF WATER - SENT TRAILER TO FILL IT UP

1045 - PULLED CASING TO 20' / WASHED CASING + CUT + REMOVED PIECE

1100 - MIXED 10TH TUB GROUT [illegible] SAME MIX / [illegible]

1248 - [illegible]

1255 - MIXED 11TH TUB GROUT - SAME MIX / POURED GROUT

1300 - MIXED 12TH TUB GROUT - SAME MIX / POURED GROUT

1312 - PULLED CASING [illegible] THREADS [illegible]
[illegible]

13[illegible] - [illegible]

1345 - MIXED 13TH [illegible]
[illegible]

1415 - MOVED RIG OFF SITE

4 1/2 - 100 lb BAGS No. 4 QUARTZ SAND

MATERIALS: [illegible]
[illegible]
[illegible]

3/27/86
DATE

[illegible]
SIGNED

AR304697

[illegible] 4/20
APPROVED

AAAP 10466

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Location of Boring:	20' SOUTH OF GW-27D - TOP OF BERM EASTERN SIDE OF YELLOW WATER RESERVOIR.
Water Level	
Time	
Date	

Boring No. 27D (II) Date 3/28/86 Sheet 1 of 8

Type of Boring Monitor Well Rig CABLE-TOOL

Casing used PVC Size 4" Drilling mud used NONE

Boring begun 3/28/86 Boring completed 3/29/86 [illegible]

Ground Elevation ______ referred to ______ Datum

Field Party: R. Albrecht; Skeeter + Jim Patterson; Jeff Austin

Depth of Casing Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	OD of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPHIC	DESCRIPTION Soil-type, color, texture, consistency, sampler driving notes; blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		SANDY CLAY W/ ~10% SAND; BROWN; HIGHLY PLASTIC; LOOSE; MOIST; ALLUVIUM.
									FAT MICACEOUS CLAY W/ NO SAND OR SILT; 10YR 5/4 - YELLOW BROWN; HIGHLY PLASTIC; STIFF; DRY; NAD; ALLUVIUM.
	1	5-6.5'			1.5'	CH	5		
						CL			CLAYEY SAND AT TOP W/ ~25% FINE SAND GRADING INTO CLAYEY SAND W/ ~25% CLAY; 10YR 4/4 - DK YELLOW BROWN; SANDY CLAY - HIGHLY PLASTIC; CLAYEY SAND - LOW TO MED. PLASTIC; LOOSE; V. SLIGHTLY MOIST; NAD; ALLUVIUM.
	2	10-11.5'			1.5'		10		
						SC			
									POORLY GRADED FINE SAND W/ ~10% CLAY; 10YR 4/4 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAD; ALLUVIUM.
	3	15-16.5'			1.0	SP-SC	15		
									POORLY GRADED FINE SAND W/ ~5% CLAY GRADING INTO A SILTY SAND W/ ~25% SILT AT BOTTOM OF SAMPLE; 10YR 5/6 YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAD; ALLUVIUM. NOTE: A 1/4" BLACK LAYER OCCURRED AT ~21', [illegible]
						SP	20		
	4	20-21.5'			1.0'				
						SM			

Signed Robert C. Albrecht Date 3/27/86

Approved RK Date 4/20

AAAP/10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Boring No. 270 (II) Date 3/29/86 Sheet 2 of 8

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Location of Boring:	
Water Level	
Time	
Date	

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									POORLY GRADED FINE SAND W/~10% SILT; 10YR 5/6 - YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM. NOTE: 1-2% FINE GRAVEL WELL ROUNDED FOUND IN BOTTOM OF SAMPLE
	5	25-26.5'			1.0'	SP-SM	25		
									POORLY GRADED FINE SAND W/~5% SILT GRADING INTO SILTY SAND W/~15% SILT; 10YR 4/6 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM.
	6	30-31.5'			1.3'	SP	30		
						SM			
									SILTY FINE SAND W/~15% SILT; 10YR 4/6 - YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM.
	7	35-36.5'			1.5'	SM	35		BOTTOM 3" IS WELL GRADED FINE TO MED. SAND W/~10% SILT AND ~5% FINE GRAVEL; 10YR 4/6 - YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM.
						SW			
									POORLY GRADED FINE SAND W/~5% SILT; 10YR 4/6 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM
	8	40-41.5'			0.7'	SP	40		

AR304699

Signed Robert C. Hackett II Date 3/29/86

Approved [illegible] Date 4/20

AAAP 10/4/80

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Boring No. 27D (II) Date 3/28/86 Sheet 3 of 8

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Location of Boring:	
Water Level	
Time	
Date	

Depth of Casing Ft.	Sample No.	Sample Depth From-To (In Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	9	45-46.5'			1.0'	SP	45		POORLY GRADED FINE SAND W/~3% SILT; 10YR 4/6 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; SOME BLACK STREAKS ~1/4" IN BOTTOM OF SAMPLE, SAME GRAINSIZE; ALLUVIUM.
									POORLY GRADED FINE SAND W/~5% SILT GRADING INTO GRAVELLY SAND W/(~15%) GRAVEL + ~10% SILT; 10YR 3/4 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAR; ALLUVIUM.
	10	50-51.5'			1.5'	SP	50		BOTTOM 5" FAT CLAY W/NO SAND OR SILT; 5Y 4/2 - OLIVE, MOTTLED; HIGHLY PLASTIC; STIFF; V. SLIGHTLY MOIST; NAR; ALLUVIUM.
						CH			NOTE: 1" LAYER ABOVE CLAY IS GRAY-BLACK GRAVELLY SAND W/~15% BLACK SILT OR CLAY.
						SP			
	11	55-56.5'			1.5'	CH	55		FAT, MICACEOUS CLAY W/NO SAND OR SILT; 5Y 3/1 - V. DK GRAY; HIGHLY PLASTIC; STIFF; V. SLIGHTLY MOIST; NAR; ALLUVIUM. NOTE: DRILLER SAID SOME SAND BETWEEN CLAY AT 51' & 55', SAID CLAY STARTED AT 53'.
	12	60-61.5'			1.5'	CH	60		FAT, MICACEOUS CLAY W/NO SAND OR SILT; 5Y 3/1 - V. DK GRAY; HIGHLY PLASTIC; STIFF; V. SLIGHTLY MOIST; NAR; ALLUVIUM.

AR304700

Signed Robert C. Hallett Date 3/28/86

Approved DK Date 4/20

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Location of Boring:

Water Level

Time

Date

Boring No. 270 (I) Date 3/28/86 Sheet 4 of 8

Type of Boring ____ Rig ____

Casing used ____ Size ____ Drilling mud used ____

Boring begun ____ Boring completed ____

Ground Elevation ____ referred to ____ Datum

Field Party: ____

Depth of Casing, Ft.	Sample No.	Sample Depth (In Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	13	65-66.5'			1.0'	CH	65		FAT MICACEOUS CLAY W/[illegible] SAND OR SILT; 5Y 3/1 - V. DK. GRAY; HIGHLY PLASTIC; STIFF; V. SLIGHTLY MOIST; NAG; ALLUVIUM.
	14	70-71.5'			1.5'	CH/CL	70		INTERBEDDED FAT MICACEOUS CLAY W/NO SAND OR SILT AND SILTY-CLAY W/~40% SILT TO FINE SAND; 5Y 4/1 - DK GRAY; SILTY-CLAY - MED. TO LOW PLASTIC; CLAY - HIGHLY PLASTIC; STIFF; SILTY-CLAY - MOIST, CLAY - SLIGHTLY MOIST; ALLUVIUM.
	15	75-76.5'			1.5'	CL/SP-SM	75		INTERBEDDED SILTY CLAY W/~10% SILT AND POORLY GRADED SAND W/~10% SILT IN FINE SAND; SAND OCCURS AS 2" LAYER AT 75.5' AND 4" LAYER AT 76.5'; CLAY - 5Y 4/1 - DK GRAY, SAND 2.5Y 4/2 - DK GRAY. BROWN; CLAY - HIGHLY PLASTIC, SAND - NOT PLASTIC; CLAY - STIFF, SAND - LOOSE; CLAY - MOIST, SAND - [illegible] LAYER MOIST, BOTTOM - WET; ALLUVIUM.
	16	80-81.5'			1.0'	SP-SM	80		POORLY GRADED FINE SAND W/~10% SILT AND 2 INCLUSIONS OF GRAY CLAY SAME CLAY AS ABOVE; 10YR 4/4 - DK YELLOW BROWN; N - PLASTIC; LOOSE; WET; FEW BLACK STREAKS IN SAND AT 81', 1/8" THICK.

AR300701

Signed Robert C. Hazlett Date 3/29/8

Approved DK Date 4/20

AAAP 10/4/83

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604
Client USATHAMA
Project LWVOW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 27D(II) Date 3/29/86 Sheet 5 of 8
Type of Boring ______ Rig ______
Casing used ______ Size ______ Drilling mud used ______
Boring begun ______ Boring completed ______
Ground Elevation ______ referred to ______
______ Datum
Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from to in Feet	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									POORLY GRADED FINE SAND W/ ~10% SILT
							85		AND ~3" GRAY CLAY LAYER AT ~86',
	17	85-86.5'			1.5'	SP-SM			SAME COLOR AS ABOVE; 10YR 4/6 - DK YELLOW BROWN; NOT PLASTIC; MED. DENSE; WET; NAB; ALLUVIUM
							BOH		
									BOTTOM OF HOLE - 86.5'
									8" CASING DOWN TO 90'
							90		

AR304702

Signed Robert C. Hazlett Date 3/29/86

Approved DK Date 4/20

Site [illegible]

Boring No. [illegible]

SHEET 6 OF 8

3/28/86

1410 - [illegible]

1420 - [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1330 - DRILLED TO 5' / BAILED HOLE [illegible] +15/-15

1342 - DROVE SAMPLE 5-6.5'

1345 - DRILLED TO 10' / BAILED HOLE +10/-20

1356 - DROVE SAMPLE 10-11.5'

1359 - PULLED TEMPORARY 8" CASING OUT / DROVE 8" CASING W/ DRIVE SHOE TO 15'

1410 - DRILLED TO 15' / BAILED HOLE +10/-10

1420 - DROVE SAMPLE 15-16.5'

1425 - ADDED 8" CASING / DROVE CASING TO 2?'

1430 - DRILLED TO 20' / BAILED HOLE +10/-20

1435 - DROVE SAMPLE 20-21.5'

1437 - ADDED CASING / DROVE CASING TO 28'

1448 - DRILLED TO 25' / BAILED HOLE +5/-20

1453 - DROVE SAMPLE 25-26.5'

1455 - DRILLED TO 30' / BAILED HOLE +5/-20

1459 - DROVE SAMPLE 30-31.5'

1501 - ADDED CASING - WELDED JOINT / DROVE CASING TO 38'

1518 - DRILLED TO 35' / BAILED HOLE +0/-30

1526 - DROVE SAMPLE 35-36.5'

1529 - DRILLED TO 40' / BAILED HOLE +0/-30

1533 - DROVE SAMPLE 40-41.5'

1535 - ADDED CASING - WELDED JOINT / DROVE CASING TO

1550 - DRILLED TO 45' / BAILED HOLE +0/-30

1557 - DROVE SAMPLE 45-46.5'

1600 - DRILLED TO 50' / BAILED HOLE

1604 - DROVE SAMPLE 50-51.5'

3/28/86 DATE

Robert C. [illegible] SIGNED

DLL 4/20 APPROVED

Site WVOW
Boring No. GW-27D II

SHEET 2 OF 8

1607 - DRILLED TO 55' / BAILED HOLE +0/-30
1620 - DROVE SAMPLER 55-56.5'
1624 - DRILLED TO 60' / BAILED HOLE +0/-40
1638 - ADDED CASING - WELDED JOINT / DROVE CASING TO
1655 - CLEARED OUT HOLE TO 60' +0/-30
1705 - DROVE SAMPLE 60-61.5'
1708 - DRILLED TO 65' / BAILED HOLE +0/-40
1727 - DROVE SAMPLE 65-66.5'
1730 - ADDED CASING - WELDED JOINT / DROVE CASING TO 65'
1745 - ACCORDING TO INSTRUCTIONS, AFTER CLAY LAYER
BREACHED + PENETRATED, HAVE TO COMPLETE
WELL IN SAME DAY - REACHED TOP OF CLAY AT
53' + CAN'T COMPLETE WELL TODAY SO SHUT
DOWN RIG - WENT TO FILL WATER TANK +
LEFT SITE FOR DAY

3/29/86

0800 - ARRIVED AT SITE - PREPARED TO DRILL
0815 - DRILLED TO 68' / BAILED HOLE +0/-30
0823 - DROVE CASING TO 68' / DRILLED TO 70 / BAILED HOLE +0/-80
0845 - DROVE SAMPLE 70-71.5'
0848 - DRILLED TO 75' / BAILED HOLE +0/-30
0858 - DROVE SAMPLER 75-76.5'
0901 - ADDED CASING - WELDED JOINT / DROVE CASING TO 80'
0925 - DRILLED TO 80' / BAILED HOLE +4/-30
0938 - DROVE SAMPLE 80-81.5'
0941 - DRILLED TO 85' / BAILED HOLE
0948 - ADDED CASING - WELDED JOINT / DROVE CASING TO 85'
1010 - CLEANED OUT HOLE TO 85' +0/-40
1020 - DROVE SAMPLE 85-86.5'
1023 - DROVE CASING TO 90'
1030 - CASING BROKEN AT 70' - BIT WOULD NOT GO TO BOTTOM OF
HOLE. SOMETHING BLOCKING IT AT 70'. MUST BE BROKEN
CASING WHICH HAS SHIFTED OVER TO BLOCK HOLE - ANY THING TO DO IS GROUT HOLE
1050 - MIXED TO GROUT USING 3 BAGS CEMENT, 1/4 BAG BENTONITE, 30 GALS WATER

3/29/86
DATE

Robert [illegible]
SIGNED

DLK 4/10
APPROVED

AR304704

Site WVOW

Boring No. GW-27D II

SHEET 8 OF 8

1100 - POURED GROUT INTO HOLE - NO WAY TO PULL 20' CASING AT BOTTOM
1105 - MIXED 2ND TUB GROUT - SAME MIX / POURED GROUT
1120 - MIXED 3RD TUB GROUT - SAME MIX / POURED GROUT
1125 - PULLED CASING TO 60' / WASHED CASING - CUT + REMOVED PIECE
1140 - PULLED CASING TO 50' / WASHED CASING - CUT + REMOVED PIECE
1155 - MIXED 4TH TUB GROUT - SAME MIX / POURED GROUT
1205 - PULLED CASING TO 40' / WASHED CASING - CUT + REMOVED PIECE /
MIXED 5TH TUB GROUT - SAME MIX / POURED GROUT
1218 - MIXED 6TH TUB GROUT - SAME MIX / POURED GROUT
1230 - PULLED CASING TO 20' / WASHED CASING - CUT + REMOVED PIECE
1240 - MIXED 7TH TUB GROUT - SAME MIX / POURED GROUT
1250 - MIXED 8TH TUB GROUT - SAME MIX / POURED GROUT
1305 - PULLED CASING TO 10' / WASHED CASING - CUT + REMOVED PIECE
1320 - MIXED 9TH TUB GROUT - SAME MIX / POURED GROUT
1340 - MIXED 10TH TUB GROUT - SAME MIX / POURED GROUT
1350 - WENT TO REFILL WATER TANK / PREPARED RIG TO
MOVE TO NEW LOCATION
1440 - RETURNED W/ WATER / CAN'T REACH ANYONE TO
AUTHORIZE NEW LOCATION FOR HOLE
1450 - LEFT SITE FOR DAY
3/30/86
0750 - MOVED RIG OFF SITE

MATERIALS: 20' - 8" STEEL CASING LEFT IN HOLE
GROUT: 30 - 94 lb. BAGS PORTLAND TYPE I CEMENT
2½ - 50 lb BAGS QUIK GEL BENTONITE AND
300 GAL WATER

3/29/86
DATE

Robert C... AR304705
SIGNED

DLK 4/20
APPROVED

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Location of Boring: 30' WEST OF GW-XXX - EASTERN SIDE ARM OF YELLOW WATER RESERVOIR	
Water Level	FIRST WATER - 14'
Time	0850
Date	3/10/86

Boring No. $\overset{III}{27D}$ Date 3/30/86 Sheet 1 of 2

Type of Boring Monitor Well Rig Cable - Tool

Casing used PVC Size 4" Drilling mud used None

Boring begun 3/30/86 Boring completed 4/1/86

Ground Elevation ______ referred to ______ Datum

Field Party: R. Harlett; Skeeter; Jim [illegible]; Jeff Austin

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION: Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		SANDY-CLAY W/~20% FINE SAND; BROWN; MOD. PLASTIC; SOFT; SLIGHTLY MOIST; ALLUVIUM.
									FAT MICACEOUS CLAY W/MINOR SAND OR SILT; 10YR 5/3 - BROWN MOTTLED; HIGHLY PLASTIC; STIFF; DRY; NAB; ALLUVIUM.
	1	5-6.5'			1.0'	CH	5		
									CLAYEY-SAND W/~20% CLAY IN FINE SAND; 10YR 4/4 - DK YELLOW BROWN; MOD. PLASTIC; LOOSE; SLIGHTLY MOIST; NAB; ALLUVIUM.
	2	10-11.5'			1.2'	SC	10		
									POORLY GRADED FINE SAND W/~10% SILT; 2.5Y 6/2 - LT. BROWN-GRAY; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM. WATER AT 14' SAMPLE WET
	3	15-16.5'			1.2'	SP-SM	15		
									POORLY GRADED FINE SAND W/~5% SILT; 2.5Y 6/2 - LT BROWN GRAY TOP + 10YR 4/3 - BROWN TO DK BROWN BOTTOM; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM.
	4	20-21.5'			1.0'	SP	20		

AR304706

Signed Robert C. Harlett Date 3/30/86

B-18

Approved DLK Date 4/20

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Boring No. 27U III Date 3/30/86 Sheet 2 of 12

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Location of Boring:	
Water Level	
Time	
Date	

Depth of Casing, Ft.	Sample No.	Sample Depth Range (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									POORLY GRADED FINE SAND W/~5% SILT; 10YR 4/4 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; 1/4" BLACK LAYER OF ORGANIC SILT OCCURS AT ~26.3'; ALLUVIUM.
	5	25-26.5'			1.5'	SP	25		
									POORLY GRADED FINE SAND W/~10% SILT; 10YR 4/4 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM.
	6	30-31.5'			1.5'	SP-SM	30		
									POORLY GRADED FINE TO MED. SAND W/~5% SILT AT THE [illegible] WITH FINE SAND W/~15% SILT IN BOTTOM 4" OF SAMPLE; 10YR 4/4 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; SOME RED-BROWN STREAKING IN BOTTOM 4" OF SAMPLE; ALLUVIUM.
	7	35-36.5'			1.2'	SP / SM	35		
									POORLY GRADED FINE SAND W/~5% SILT; 10YR 3/4 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; NAB; ALLUVIUM.
	8	40-41.5'			1.5'	SP	40		

AR304707

Signed Robert C. Hazlett Date 3/30/86

Approved DK Date 4/20

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project NVOW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 27D III Date 3/30/86 Sheet 3 of 12

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									Poorly graded fine sand w/~5% silt; 10YR 3/4 - Dk yellow brown; not plastic; loose; wet; NAB; alluvium.
	9	45-46.5'			1.0'	SP	45		
									Well graded gravelly sand w/~10% silt, ~30% subrounded fine gravel and ~20% fine to med. sand; 10YR 3/4 - Dk. yellow brown; not plastic; med dense; wet; 3-1/8" black silty-organic bands in bottom of sample; alluvium.
	10	50-51.5'			1.5'	SW-SM	50		Note: driller brought up ~10% rounded pieces of rock from 53-55'
									Fat micaceous clay w/trace sand or silt; 5Y 4/1 - Dk gray; highly plastic; stiff; v. slightly moist; NAB; alluvium.
	11	55-56.5'			1.5'	CH	55		
									Fat micaceous clay w/trace sand or silt; 5Y 4/1 - Dk gray; highly plastic; stiff; v. slightly moist; NAB; alluvium.
	12	60-61.5'			1.2'	CH	60		

AR304708

Signed Robert P. [illegible] Date 3/30/86

Approved ______ Date ______

AAAP 10488

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 22D III Date 3/10/86 Sheet 4 of 12

Type of Boring ____ Rig ____

Casing used ____ Size ____ Drilling mud used ____

Boring begun ____ Boring completed ____

Ground Elevation ____ referred to ____ Datum

Field Party: ____

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	13	65-66.5'			1.5'	CH	65		FAT, MICACEOUS CLAY w/NO SAND OR SILT; 5Y 4/1- DK GRAY; HIGHLY PLASTIC; STIFF; V. SLIGHTLY MOIST; NAB; ALLUVIUM.
	14	70-71.5'			1.5'	CH/CL	70		INTERBEDDED FAT MICACEOUS CLAY w/NO SAND & SILT AND SILTY-CLAY w/~25% SILT; 5Y 4/1. DK GRAY; CLAY-HIGHLY PLASTIC; SILTY CLAY-MOD. PLASTIC; SOFT; CLAY-SLIGHTLY MOIST; SILTY CLAY-MOIST; ALLUVIUM.
	15	75-76.5'			1.5'	CH/CL	75		INTERBEDDED FAT MICACEOUS CLAY w/NO SAND OR SILT AND SILTY-CLAY w/~20% SILT; 5Y 4/1-DK GRAY; CLAY-HIGHLY PLASTIC, SILTY-CLAY-MOD. PLASTIC; SOFT; MOIST; AT 74.5' IS LAYER OF SILTY CLAY w/~10% SILT; 10YR 4/4. DK YELLOWISH BROWN, BANDED GRAY & BROWN w/ 1/4" LAYER HARD, MICACEOUS, FINE GRAINED ROCK; ALLUVIUM.
	16	80-81.5'			1.2'	SP-SM	80		POORLY GRADED FINE SAND w/~10% SILT; 2.5Y 5/4-LT. OLIVE BROWN; NON PLASTIC; LOOSE; WET; RED-BROWN AND BROWN BANDING PRESENT; ALLUVIUM.

AR304709

Signed [signature] Date 3/11/86

Approved D.K. Date 4/20

AAAP 104/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Boring No. 27D III Date 3/21/86 Sheet 5 of 12

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Location of Boring:	
Water Level	
Time	
Date	

Depth of Casing, Ft.	Sample No.	Sample Depth From-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	17	85-86.5'			1.5'	SP-SM	85		POORLY GRADED FINE SAND W/<10% SILT AND SMALL CLAY LENSES OCCUR SPORADICALLY THROUGHOUT. A 1" CLAY LAYER AT BOTTOM OF SAMPLE; 10YR 3/4-DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; ALLUVIUM.
	18	90-91.5'			1.5'	CH/SP-SM	90		INTERBEDDED FAT CLAY W/NO SILT OR SAND AND POORLY GRADED FINE SAND W/~10% SILT; 10YR 5/4-YELLOW-BROWN; CLAY-HIGHLY PLASTIC, SAND-NOT PLASTIC; CLAY-SOFT, SAND-LOOSE; CLAY-SLIGHTLY MOIST; SAND-WET; ALLUVIUM.
	19	95-96.5'			1.0'	CH/SP-SM	95		INTERBEDDED FAT CLAY W/NO SAND OR SILT AND POORLY GRADED FINE SAND W/~10% SILT; 10YR 4/4-DK YELLOW BROWN; SAND-NOT PLASTIC; CLAY-HIGHLY PLASTIC; SAND-LOOSE, CLAY-SOFT; SAND-WET, CLAY SLIGHTLY MOIST; 1/4" BLACK ORGANIC-SILT LAYER AT 96.5'; ALLUVIUM.
	20	100-101.5'			1.2'	SP-SM	100		POORLY GRADED FINE SAND W/<10% SILT; TOP 6" 10YR 4/4-DK YELLOW BROWN W/ RED-BROWN-BLACK BANDING AT BOTTOM, BOTTOM 8" 2.5Y 4/2-DK GRAY BROWN W/ BLACK MOTTLING; NOT PLASTIC; LOOSE; WET; ALLUVIUM.
	21	103-104'			0.2'	SAND-STONE	103 BOH		CEMENTED SANDSTONE - FINE-GRAINED WELL CEMENTED, IRON CEMENTED S.S.; 10YR 7/1-LT. GRAY W/ 10YR 4/4-DK YELLOW BROWN STREAKING; ABOVE S.S. [illegible] FINE SAND, CLAY, GRAVEL MIXED, PROBABLY NOT IN SITU. BOTTOM OF HOLE - 104'

NOTE: AUGER GROUND OUT ON SANDSTONE; HOLE ADVANCED AT 103'.

Signed Robert C. Hauser Date 3/21/86

Approved DLK Date 4/20

B-22

AB304710

Site WVOW
Boring No. GW-27D III

SHEET 6 OF 12

3/30/86 | WATER USED/REC

0900 - ARRIVED AT NEW LOCATION - SET-UP RIG, PREPARED TO DRILL	
0812 - DROVE 8" CASING TO 3' TO START HOLE	
0817 - DRILLED TO 5' / BAILED HOLE	+15/-15
0828 - DROVE SAMPLE 5-6.5'	
0832 - DRILLED TO 10' / BAILED HOLE	+10/-10
0844 - DROVE SAMPLE 10-11.5'	
0846 - DRILLED TO 15' / BAILED HOLE	+5/-15
0851 - DROVE SAMPLE 15-16.5'	
0853 - ADDED CASING - WELDED JOINT - LET WELD COOL / DROVE CASING TO 15'	
0918 - CLEANED HOLE TO 15'	-10
0923 - ADDED CASING - WELDED JOINT / DROVE CASING TO 25'	
0938 - DRILLED TO 20' / BAILED HOLE	+5/-20
0942 - DROVE SAMPLE 20-21.5'	
0945 - DRILLED TO 25' / BAILED HOLE	+5/-20
0949 - DROVE SAMPLE 25-26.5'	
0952 - ADDED CASING - WELDED JOINT / LET WELD COOL / DROVE CASING TO 35'	
1010 - DRILLED TO 30' / BAILED HOLE	+5/-30
1017 - DROVE SAMPLE 30-31.5'	
1019 - DRILLED TO 35' / BAILED HOLE	+5/-30
1026 - DROVE SAMPLE 35-36.5'	
1028 - ADDED CASING - WELDED JOINT - LET WELD COOL / DROVE CASING TO 45'	
1050 - DRILLED TO 40' / BAILED HOLE	+0/-30
1100 - DROVE SAMPLE 40-41.5'	
1102 - DRILLED TO 45' / BAILED HOLE	+0/-30
1112 - DROVE SAMPLE 45-46.5'	
1114 - ADDED CASING - WELDED JOINT - LET WELD COOL / DROVE CASING TO 50'	
1142 - DRILLED TO 50' / BAILED HOLE	+0/-60
1205 - DROVE SAMPLE 50-51.5'	
1208 - SAND HEAVED UP INTO HOLE 1.5' SO DECIDED TO [illegible]	

3/30/86 DATE

Robert [illegible] SIGNED

DLC 4/20 APPROVED

AR304711

Site INVOW
Boring No. GW-27D III

SHEET 7 OF 12

WATER LEVELS

1210 - CLEANED OUT HOLE TO 50' AGAIN -8/-30
1215 - DROVE SAMPLE 50-51.5'
1218 - DROVE CASING TO 52'
1223 - DRILLED TO 54' / BAILED HOLE +5/-20
1230 - DROVE CASING TO 55' / DRILLED TO 55' / BAILED HOLE +5/-40
1250 - DROVE SAMPLE 55-56.5'
1253 - HOLE DOESN'T FEEL RIGHT TO DRILLER - FELT LIKE SAND ON TOP OF BIT, MAY BE JUST HEAVING UP FROM BOTTOM BUT DECIDED TO PULL CASING FEW INCHES TO SEE IF ITS SEPARATED
1300 - PULLED CASING - EVERYTHING SEEMS FINE / RAN BAILER INTO HOLE - SAND HEAVING UP FROM BOTTOM -20
1305 - DROVE CASING BACK DOWN TO 55' / BAILED HOLE -40
1310 - BROKE FOR LUNCH
1335 - BAILED HOLE / DRILLED TO 60' / BAILED HOLE -10/-40/-30
1349 - DROVE SAMPLE 60-61.5'
1352 - DRILLED TO 64' / BAILED HOLE +0/-30
1403 - ADDED CASING - WELDED JOINT - BAT WELD CASING / DROVE CASING TO 63'
1425 - DRILLED TO 65' / BAILED HOLE +0/-30
1444 - DROVE CASING TO 65' / CLEANED HOLE TO 65' -70
1458 - DROVE SAMPLE 65-66.5'
1502 - SHUT DOWN RIG - AFTER CLAY LAYER PENETRATED HAVE TO COMPLETE WELL TO MINIMIZE CONTAMINATION OF LOWER AQUIFER FROM UPPER AQUIFER - HIT CLAY AT 54' + NOT ENOUGH TIME TO COMPLETE DRILLING + INSTALL WELL SO QUIT FOR DAY
1520 - LEFT SITE FOR DAY / FILLED WATER TANK

3/31/86

0740 - ARRIVED AT SITE - PREPARED TO DRILL
0745 - DRILLED TO 70' / BAILED HOLE +3/-40
0757 - DROVE SAMPLE 70-71.5'
0800 - DRILLED TO 75' / BAILED HOLE +5/-30
0808 - DROVE SAMPLE 75-76.5'
0811 - ADDED CASING - WELDED JOINT / DROVE CASING TO 75'

3/31/86 DATE

ROBERT C. [illegible] SIGNED

AR304712

DLK 4/20 APPROVED

Site WVOW

Boring No. GW-27D III

SHEET 8 OF 12

	WATER USED (GAL)
0842 - DRILLED TO 80' / BAILED HOLE	+8/-30
0854 - ADDED CASING - WELDED JOINT - LET WELD COOL / DROVE CASING TO 83'	
0915 - CLEANED OUT HOLE TO 80'	+0/-30
0921 - DROVE SAMPLER 80-81.5'	
0924 - DROVE CASING TO 85'	
0931 - DRILLED TO 85' / BAILED HOLE	+0/-30
0935 - DROVE SAMPLER 85-86.5'	
0938 - ADDED CASING - WELDED JOINT - LET WELD COOL / DROVE CASING TO 94.5'	
1013 - DRILLED TO 90' / BAILED HOLE	+0/-30
1020 - DROVE SAMPLER 90-91.5'	
1023 - DRILLED TO 95' / BAILED HOLE	+0/-40
1034 - DROVE SAMPLER 95-96.5'	
1037 - DRILLED TO 97' / BAILED HOLE	+0/-50
1042 - DROVE CASING TO 97'	
1054 - ADDED CASING - WELDED JOINT - LET WELD COOL / DROVE CASING TO 100'	
1112 - DRILLED TO 100' / BAILED HOLE	+0/-30
1121 - DROVE SAMPLER 100-101.5'	
1124 - ADDED CASING - WELDED JOINT DROVE CASING TO 103'	
1145 - DRILLED TO / BAILED HOLE	+60/-50
1215 - DROVE SAMPLER 103-104.5'	
1218 - BAILED HOLE	-80
1235 - BROKE FOR LUNCH	
1255 - BAILED HOLE / MEASURED TO BOTTOM OF HOLE - 103.5'	-60
1310 - BEGAN PLACING 4" PVC CASING INTO HOLE STARTING W/ 15' SCREEN (10' THEN 5' SECTIONS) THEN 90' PVC CASING (9-10' SECTIONS) W/ BOTTOM PLUG	
1325 - SAND HEAVED - FILLED HOLE TO 100' - PULLED PVC BACK OUT OF HOLE TO BAIL SAND OUT	
1335 - BAILED HOLE + ADDED WATER TO KEEP SAND DOWN	+85/-40
1348 - PLACED PVC INTO HOLE AGAIN - SAME AMOUNT + ORDER / BOTTOM OF SCREEN AT 103'	

3/31/86 — DATE

Robert C. Hackett — SIGNED

AR304713

D.L. 4/20 — APPROVED

Site WIDOW

Boring No. GW-27D III

SHEET 9 OF 12

WATER USED (GALS)

1401 - POURED 4 BAGS SAND

1412 - PULLED 8" CASING TO 95' / WASHED OUT + REMOVED PIECE

1430 - POURED 3½ BAGS SAND

1440 - PULLED 8" CASING TO 83' / WASHED OUT, + REMOVED PIECE

1450 - MEASURED TO TOP OF SAND - 83' - USED 7½ BAGS SAND

1500 - MIXED TUB GROUT USING 3 BAGS CEMENT, ½ BAG QUIKGEL, 25 GAL WATER

1518 - POURED 2 BUCKETS BENTONITE PELLETS 3/8" / PULLED 8" CASING TO 75' / WASHED OUT, + REMOVED PIECE

1538 - BENTONITE PELLETS BRIDGED INSIDE 8" CASING - STICKING TO SIDES OF CASING - TRIED DROPPING WEIGHT DOWN TO PUSH THEM DOWN BUT DIDN'T WORK - DON'T KNOW WHAT THICKNESS OF PELLETS ARE STUCK IN 8" CASING OR IF GROUT COULD GET THROUGH THEM - DECIDED TO PULL PVC OUT OF HOLE + CLEAN OUT HOLE TO BOTTOM + START INSTALLATION AGAIN.

1555 - BEGAN PULLING PVC OUT OF HOLE.

1610 - REDRILLED HOLE TO 90' / BAILED HOLE -100

1625 - ADDED 8" CASING - WELDED JOINT / DROVE 8" CASING TO 85'

1655 - ADDED CASING - WELDED JOINT / DROVE CASING TO 98'

1720 - DRILLED TO 98' / BAILED HOLE +0/-50

1745 - ADDED CASING - WELDED JOINT / DROVE CASING TO 103'.

1810 - REDRILLED / BAILED HOLE TO 103' / ADDED WATER TO KEEP HOLE +50/-100

1845 - MEASURED TO BOTTOM OF HOLE - 103' / WASHED PVC + BEGAN PUTTING IT INTO HOLE - SAME AMOUNT + ORDER

1855 - POURED 4 BAGS SAND

1905 - 8" CASING BROKE AT JOINT ~20' FROM SURFACE / PULLED PVC CASING OUT OF HOLE IN ORDER TO USE CASING SPEAR TO RETRIEVE 8" BREAK

1925 - STRUNG UP LIGHTS AROUND RIG - REMOVED DRILL BIT TO REPLACE W/ CASING SPEAR

1930 - ATTACHED CASING SPEAR

1945 - PREPARED TO PUT CASING SPEAR DOWN HOLE

1955 - LOWERED CASING SPEAR INTO 8" CASING / HAD TO RE-ADJUST CASING SPEAR - BROUGHT BACK OUT OF HOLE

3/31/86
DATE

Robert R. [illegible]
SIGNED

DJK 4/20
APPROVED

AR304714

Site WVOW

Boring No. GW-27D III

SHEET 10 OF 12

WATER USED (GALS)

2000 - LOWERED CASING SPEAR BACK INTO HOLE.

2020 - CAN'T GET CASING SPEAR TO GRAB CASING - NOT OPENING UP WIDE ENOUGH OR NOT CATCHING FOR SOME REASON - CONTINUE TRYING

2110 - FINALLY GRABBED + PULLED CASING - BREAK AT 30'

2125 - RE-WELDED CASING AT BREAK

2135 - LET WELD COOL / PUMPED + CLEANED OUT GROUT TUB

2140 - PULLED CASING SPEAR OUT OF CASING + ATTACHED DRIVING BLOCKS

2210 - BEGAN DRIVING CASING BACK INTO HOLE

2230 - FINISHED DRIVING CASING TO 102' - CLEANED UP + SHUT DOWN RIG FOR NIGHT

2240 - LEFT SITE FOR NIGHT

4/1/86

0845 - ARRIVED AT SITE - TOOK OFF CASING SPEAR - PREPARED TO REDRILL / BAIL HOLE

0920 - BEGAN REDRILLING / BAILING HOLE TO 103' | +50/-70

1010 - MEASURED TO BOTTOM OF HOLE - 103'

1015 - BEGAN PLACING PVC INTO HOLE - SAME AMOUNT + ORDER

1030 - SAND HEAVED UP 4-5' / TOOK PVC BACK OUT OF HOLE TO RE-BAIL SAND OUT

1040 - BAILED HOLE / ADDED WATER TO KEEP SAND DOWN | +50/-30

1050 - WASHED PVC + PLACED INTO HOLE - SAME AMOUNT + ORDER

1105 - POURED 3 BAGS SAND / BOTTOM OF PVC AT 102.5'

1114 - PULLED 8" CASING TO 92' / WELDED, CUT, + REMOVED PIECE

1131 - POURED 4 BAGS SAND

1140 - PULLED 8" CASING TO 83' / WELDED, CUT, + REMOVED PIECE

1150 - MEASURED TO TOP SAND - 81' / USED 7 BAGS SAND

1155 - MIXED BENTONITE SLURRY USING 1/4 BAG QUIKGEL + 10 GALS WATER / USED SLURRY INSTEAD OF PELLETS BECAUSE WATER IN HOLE THICK W/ SILT + PELLETS FAIL TO FLOW + STICK TO SIDES OF 8" CASING - ALSO WATER LEVEL HIGH IN HOLE DUE TO ADDING ALOT OF WATER TO KEEP SAND FROM HEAVING

1205 - POURED BENTONITE SLURRY THROUGH TREMIE PIPE INTO HOLE / SHOULD FORM A 4-5' SEAL

4/1/86 — DATE

ROBERT [illegible] — SIGNED

DLK 4/20 — APPROVED

AR304715

Site WVOW
Boring No. GW-27D II

SHEET 11 OF 12

1220 - MIXED TUB GROUT USING: 2 BAGS CEMENT, 1/5 BAG QUIKGEL, 15 GALS WATER
1230 - POURED GROUT THROUGH TREMMIE PIPE
1240 - BROKE FOR LUNCH / LET BENTONITE SEAL SET
1305 - CUT PVC CASING TO 2.2' ABOVE GROUND
1310 - PULLED 8" CASING TO 75' / WASHED, CUT, + REMOVED PIECE
1320 - MIXED TUB GROUT USING: 3 BAGS CEMENT, 1/4 BAG QG, 20 GALS WATER
1330 - POURED GROUT / 8" CASING SLIPPED ~1' DOWN INTO HOLE - HAD TO
DIG TO GET TO IT + RAISE IT BACK UP
1345 - RETRIEVED CASING / MIXED 2ND TUB GROUT - SAME MIX / POURED GROUT
1402 - MIXED 3RD TUB GROUT - SAME MIX / POURED GROUT
1415 - PULLED 8" CASING TO 60' / WASHED, CUT, + REMOVED PIECE
1425 - MIXED 4TH TUB GROUT - SAME MIX / POURED GROUT
1435 - PULLED CASING TO 50' / WASHED, CUT, + REMOVED PIECE
1440 - MIXED 5TH TUB GROUT - SAME MIX / POURED GROUT
1450 - PULLED 8" CASING TO 40' / WASHED, CUT, + REMOVED PIECE
1505 - MIXED 6TH TUB GROUT - SAME MIX / POURED GROUT
1510 - PULLED CASING TO 35' / WASHED, CUT, + REMOVED PIECE /
MIXED 7TH TUB GROUT - SAME MIX / POURED GROUT
1525 - PULLED 8" CASING TO 25' / WASHED, CUT, + REMOVED PIECE /
MIXED 8TH TUB GROUT - SAME MIX
1540 - PULLED 8" CASING TO 15' / WASHED, CUT, + REMOVED PIECE /
POURED 8TH TUB GROUT
1550 - MIXED 9TH TUB GROUT - SAME MIX / POURED GROUT
1615 - MIXED 10TH TUB GROUT - SAME MIX / POURED GROUT
1625 - RAN OUT OF WATER - SENT TRAILER TO FILL-UP / BEGAN
CLEAN-UP, PREPARING TO TEAR DOWN RIG
1645 - MIXED 11TH TUB GROUT - SAME MIX / POURED GROUT
1715 - RETURNED W/ WATER - MIXED 12TH TUB GROUT - SAME MIX / POURED GROUT
1730 - MIXED 13TH TUB GROUT - SAME MIX / POURED GROUT
1745 - MIXED 14TH TUB GROUT - SAME MIX
1800 - PULLED 8" CASING OUT OF TOP OF HOLE / WASHED CASING
1810 - MIXED 15TH TUB GROUT - SAME MIX / BEGAN LOWERING TOWER
ON RIG / POURED GROUT
1820 - WASHED DOWN RIG + EQUIPMENT / PREPARED TO MOVE RIG

4/1/86 — DATE

[illegible signature] — SIGNED

AR304716

D.K. 4/20 — APPROVED

Site WNOW
Boring No. GW-27D III

SHEET 12 OF 12

1834- LOWERED DRILLING RIG TOWER / PUT PROTECTIVE STEEL CASING OVER PVC w/ LOCK + PVC CAP
1845- MOVED RIG OFF SITE
1955- LEFT SITE

MATERIALS:
15' - 4" PVC SCREEN, SCH 40, SLOT 0.020" (5' + 10' SECTIONS)
99.7' - 4" PVC CASING, SCH 40 (9-10' SECTIONS)
1 - PVC SCREW-IN BOTTOM PLUG
1 - PVC SLIP-ON TOP CAP
18½ (7)* 100 lb BAGS No. 4 QUARTZ SAND
2+ - 50 lb BUCKETS BENTONITE PELLETS 3/8"
BENTONITE SLURRY: ¼ - 50 lb BAG QUIKGEL BENTONITE MUD
10 GALS WATER
GROUT: 47-94 lb. BAGS PORTLAND TYPE I CEMENT
4 - 50 lb. BAGS QUIKGEL BENTONITE MUD
315 GALS WATER

* USED 11½ BAGS SAND IN TWO ABORTED ATTEMPTS TO SET WELL. FINAL INSTALLATION OF WELL USED 7 BAGS SAND
+ PROBLEMS w/ PELLETS CAUSED WELL TO BE RE-DRILLED. FINAL INSTALLATION USED BENTONITE SLURRY

4/1/86
DATE

Robert C. [illegible]
SIGNED

[illegible] 4/20
APPROVED

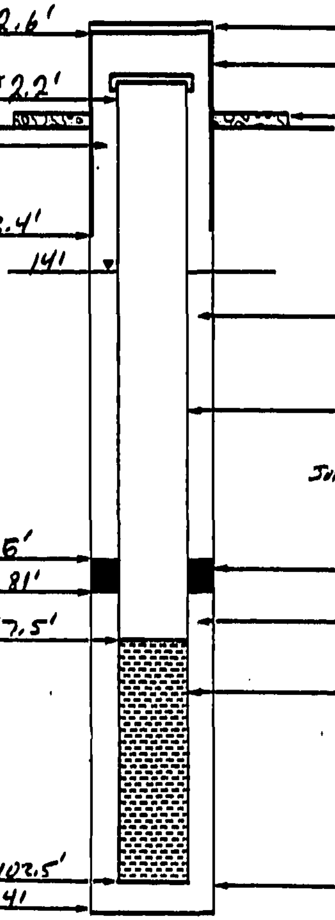
AR304717

AAAP 10/4/86

MONITOR WELL CONSTRUCTION

Logged By: Robert Hallett Client: USA-THAMA
Drilling Contractor: Bowser Morner Location: Wilow
Driller's Name: Skeeter Robinson Job Number: 84604
Well Number: GW-27A II Date/Time: Start 3/20/86 Finish 4/1/86
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing +2.6'
Top of Well Casing +2.2'
Top of Cement 0'
Bottom of Protective Casing 3.4'
FIRST Ground Water 14'
Top of Bentonite Seal 76'
Top of Gravel Pack 81'
Top of Screen 87.5'
Bottom of Screen 102.5'
Total Depth of Bore Hole 104'

Locking Cap
Protective Pipe Type, Diameter 6" Steel
Cement/Gravel Pad
Type of Grout Cement/Bentonite 20:1
Casing:
Type PVC SCH 40
Diameter 4"
~~Couplings~~ Joints: Type Flush Threaded
Number 10
Depths 7.5', 17.5', 27.5', 37.5', 47.5', 57.5', 67.5', 77.5', 87.5', 97.5'
Type of Plug Bentonite Slurry
Gravel Pack: Material No. 4 Quartz Sand
Screen:
Type PVC SCH 40
Diameter 4"
Length 15' (5' + 10' sections)
Slot Size 0.0200"
Bore Hole Diameter 8"

AR304718

NOT TO SCALE

Approved: DL 4/20

NAS - NO APPARENT BEDDING

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Location of Boring: NORTH END OF TNT AREA	
Water Level	[illegible] 22'
Time	1710
Date	3/12/86

Boring No. OW-43 Date 3/12/86 Sheet 1 of 4

Type of Boring [illegible] Rig CABLE-TOOL

Casing used PVC Size 4" Drilling mud used NONE

Boring begun 3/12/86 Boring completed 3/12/86

Ground Elevation ______ referred to ______ Datum

Field Party: [illegible]

Depth of Casing, ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	Wt of Sampler	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0		POORLY GRADED FINE SAND; [illegible] DRY; [illegible]
	1	5-6.5'			1'	SP-SC	5		POORLY GRADED FINE GRAINED SAND [illegible] 10% [illegible] LOW PLASTICITY; [illegible] NAB; [illegible] DRY.
	2	10-11.5'			1.1'	SP-SC	10		POORLY GRADED FINE SANDS [illegible] CLAY [illegible] BROWN; [illegible] NAB; [illegible]
	3	[illegible]			1.2'	SP-SC	15		POORLY GRADED FINE SAND [illegible] NAB; [illegible] SAMPLER [illegible] SAND [illegible]
	[illegible]	[illegible]			.7'	SC	20		POORLY GRADED FINE [illegible] GRAVEL [illegible] WET; NAB; [illegible]

Signed Robert C. [illegible] Date 3/12/86

Approved [illegible] Date [illegible]

AR304719

AAAP 10460

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. GW 9/3 Date 3/12/86 Sheet 2 of 4

Type of Boring ____ Rig ____

Casing used ____ Size ____ Drilling mud used ____

Boring begun ____ Boring completed ____

Ground Elevation ____ referred to ____ Datum

Field Party: ____

Depth of Casing Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									[illegible] GRAVEL-SAND [illegible] 25' [illegible]
	5	25-26.5'			1.0'	SC	25		[illegible] SAND [illegible] GRAVEL; 10YR 4/3 [illegible]
	6	30-31.5'			1.5'	SC	30		[illegible] SAND [illegible] AT [illegible] OF SAMPLE [illegible]
						CH			FAT CLAY W/ [illegible] SAND; 10YR [illegible]
	7	35-37'			1.0'	SC	35		[illegible] FINE SAND [illegible]
									Bottom of hole · 30.5'

AR304720

Signed Robert C. Hazlett Date 3/12/86

Approved [illegible] Date [illegible]

Site WVOW

Boring No. GW-43

SHEET 3 OF 4

3/11/86

1930 - ARRIVED AT SITE - DROPPED OFF EQUIPMENT

3/12/86

0720 - ARRIVED AT SITE - PREPARED RIG FOR DRILLING

0750 - CHECKED SITE W/MAGNETOMETER - FOUND NOTHING

0800 - CONTINUED PREPARING RIG

0815 - BEGAN DRIVING HOLE - USED ~4 GALS WATER +4

0840 - BAILED HOLE - BROUGHT OUT ~2 GALS -2

0845 - DROVE SAMPLE AT 5'-6.5' USING SPLIT SPOON

0850 - DROVE HOLE* - USED ~7 GALS WATER +7

0900 - BAILED HOLE - MINUS ~8 GALS WATER -8

0906 - DROVE HOLE - ADD ~3 GALS WATER +3

0908 - BAILED - MINUS ~7 GALS WATER -7

0911 - DROVE SAMPLE - 10-11.5'

0919 - DROVE 8" CASING* (12'3¾" LENGTH) - STARTED CASING

0925 - DROVE HOLE - ADD ~7 GALS WATER + 3 GALS +10

0930 - BAILED HOLE - MINUS ~7 GALS -7

0937 - DROVE SAMPLE - 15-16.5'

0945 - DROVE 8" CASING (9'9" LENGTH)

0952 - DROVE HOLE & CASING - ADD ~10 GALS WATER +10

0959 - BAILED HOLE - MINUS ~20 GALS WATER -20

1007 - DROVE SAMPLE 20-21.5'

1020 - DROVE HOLE - ADD ~5 GALS +5

1030 - BAILED HOLE - MINUS ~10 GALS -10

1035 - DROVE 8" CASING (7'11" LENGTH)

1040 - BAILED HOLE - MINUS ~5 GALS -5

1047 - DROVE SAMPLE 25-26.5'

1055 - DROVE HOLE - ADD 5 GALS WATER +5

1102 - DROVE CASING 19'11¼" - WELDED TO CASING IN HOLE (ADD 2¼")

1125 - BAILED HOLE - MINUS ~20 GALS -20

1135 - DROVE SAMPLE 30-31.5'

1140 - DROVE HOLE & CASING

1203 - DROVE SAMPLE 35-36.5'

1215 - BROKE FOR LUNCH

TOTAL WATER LOST:

0 GALS

* "DROVE HOLE" REFERS TO DRILLING HOLE

"DROVE CASING" REFERS TO PUTTING CASING IN GROUND IS [illegible] [illegible]

3/12/86
DATE

Robert C. Hazlett
SIGNED

DLK 10 [illegible] 86
APPROVED

AR304721

Site WVIW

Boring No. GW-43

1630 - SUPPLIES (PVC, SAND, BENTONITE PELLETS, ETC.)
FINALLY ARRIVE - LATE DUE TO BRUSSEL-[illegible]
TRUCK BREAKDOWN

1710 - MEASURED TO BOTTOM OF HOLE - 35.5'
AND WATER LEVEL - 22'

1715 - BEGAN PLACING PVC INTO HOLE - 15' OF SCH 40, 4"
SCREEN SLOT 0.0100" W/BOTTOM PLUG, AND 25' OF
SCH 40 4" PVC CASING - BOTTOM OF SCREEN AT 35'

1720 - BEGAN POURING SAND (No. 4 QUARTZ) - USED 3 [illegible] BAGS

1725 - BEGAN PULLING CASING (START 9')

1730 - POURED MORE SAND - 2 BAGS

1735 - PULLED CASING

1740 - POURED MORE SAND - 2 BAGS

1745 - PULLED CASING

1750 - POURED MORE SAND - 1 BAG - TOP OF SAND 14.7' - 7 BAGS TOTAL

1753 - POURED BENTONITE PELLETS (3/8") - 2½ BUCKETS (50 lbs)

1800 - PULLED CASING

1810 - POURED MORE BENTONITE - ½ BUCKET - TOP AT 10.9' - [illegible]
TO GO GET ANOTHER BUCKET OF BENTONITE -
BEGAN PRESSURE WASHING RIG + CASING

1830 - BENTONITE ARRIVES - POURED 1 BUCKET PELLETS +
ADDED 1 BUCKET WATER - TOP AT 8.7'

1835 - BEGAN MIXING GROUT - HAD TO USE [illegible] BENTONITE
PELLETS BROUGHT [illegible] SENT TO SITE
BY [illegible] - USED ABOUT 1/4 BUCKET PELLETS,
4 - 94 lb BAGS CEMENT (PORTLAND TYPE I FROM LOUISVILLE
CEMENT CO. LOUISVILLE KY) AND 20 GALLONS OF WATER

1845 - BEGAN POURING GROUT - THRU TREMMIE PIPE

1900 - PULLED LAST OF CASING + PRESSURE WASHED IT

1910 - BEGAN BREAKING DOWN RIG - CUT PVC TO 2.2' ABOVE GROUND

1930 - PLACED PROTECTIVE CASING OVER PVC + LOCKED IT

MATERIALS: 15' OF 4" DIA SCH 40 PVC SCREEN, SLOT 0.0100"
22.2' OF 4" DIA SCH 40 PVC CASING, 1 - PVC BOTTOM PLUG, 1 - PVC SLIP-ON CAP

7 - 100 lb BAGS #4 QUARTZ SAND
4 - 50 lb BUCKETS 3/8" BENTONITE PELLETS
GROUT: 4 - 94 lb BAG PORTLAND TYPE I CEMENT
10 lbs CRUSHED BENTONITE PELLETS
20 GAL WATER

3/12/86
DATE

Robert C. Hazlett
SIGNED

[illegible]
APPROVED

2/13/86 [illegible]

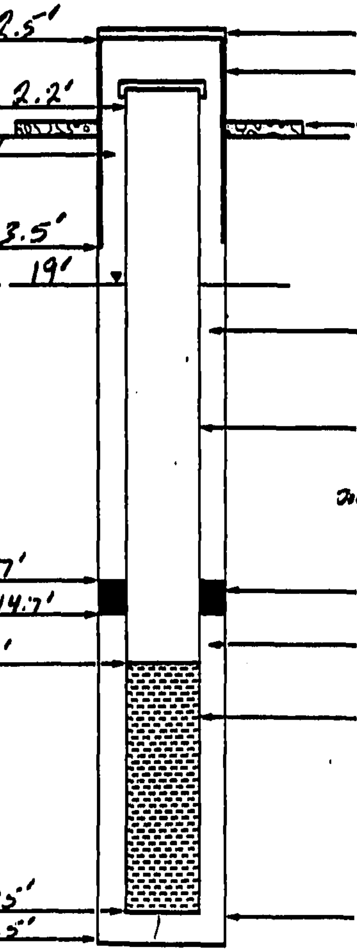
AAAP 10/4/86

MONITOR WELL CONSTRUCTION

Logged By: Robert Hazlatt
Client: USATHAMA
Drilling Contractor: Bowser-Morner
Location: WVOW
Driller's Name: Skaater Pottabun
Job Number: 84604
Well Number: GW-43
Date/Time: Start 0710-3/11 Finish 1910-3/12/96

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing 2.5'
Locking Cap
Protective Pipe Type, Diameter Steel, 6"
Top of Well Casing 2.2'
Cement/Gravel Pad
Top of Cement 0'
Bottom of Protective Casing 3.5'
First Ground Water 19'
Type of Grout Cement/Bentonite

Casing:
Type PVC SCH 40
Diameter 4"
~~Couplings:~~ Joints Type Flush threaded
Number 4
Depths 0', 10', 20', 25' (approx. screen)

Top of Bentonite Seal 9.7'
Type of Plug Bentonite 5/8" Dia. Ball
Top of Gravel Pack 14.7'
Gravel Pack: Material No. 4 Quartz Sand
Top of Screen 20'

Screen:
Type PVC SCH 40
Diameter 4"
Length 15' (10' + 5' sacrificial)
Slot Size 0.0100"

Bottom of Screen 35'
Bore Hole Diameter
Total Depth of Bore Hole 35.5'

AR304723

NOT TO SCALE

AR304723

Robert C Hazlatt

AR304724

AAAP 10466

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	First water 14'
Time	0920
Date	4/2/86

Boring No. 44 Date 4/2/86 Sheet 1 of 4

Type of Boring [illegible] Rig Cable Tool

Casing used PVC Size 4" Drilling mud used None

Boring begun 4/2/86 Boring completed 4/4/86

Ground Elevation ______ referred to ______ Datum

Field Party: [illegible] Jeff Austin

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		Silty clay w/~10% silt; 2.5Y 5/4 - lt. olive brown; highly plastic; soft; slightly moist; alluvium.
									Fat micaceous clay w/no sand or silt; 10YR 5/4 - yellow brown; highly plastic; stiff; slightly moist; NAB; alluvium.
	1	5-6.5'			1.2'	CH	5		
									Sandy clay w/~10% fine sand grading into poorly graded clayey sand w/~15% clay at sample bottom and 1" layer of sandy clay at bottom; 10YR 5/6 - yellow brown; clay - highly plastic, sand - not plastic; clay - soft, sand - loose; moist; alluvium.
	2	10-11.5'			1.5'	CL	10		
						SC			
									Poorly graded fine sand w/~10% silt; 10YR 5/6 - yellow brown; not plastic; loose; wet; NAB; alluvium.
	3	15-16.5'			1.2'	SM	15		
									Poorly graded fine sand w/~5% silt grading into well graded fine to med sand w/~5% silt and ~2% rounded gravel; 10YR 4/6 - dk yellow brown; not plastic; loose; wet; NAB; alluvium
	4	20-21.5'			1.5'	SP	20		
						SW			

First water ~14' [illegible] wet

AR300725

Signed [illegible signature] Date 4/6/86

B-36 Approved [illegible signature] Date 8Apr86

AAAP 10/469

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 44 Date 4/3/86 Sheet 2 of 4

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									POORLY GRADED FINE SAND w/<5% SILT; 2.5Y 5/4 - LT. OLIVE BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM
	5	25-26.5'			1.5'	SP	25		
									POORLY GRADED FINE SAND w/<5% SILT; 10YR 4/6 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM
	6	30-31.5'			1.1'	SP	30		
									POORLY GRADED FINE SAND w/<5% SILT; 10YR 4/6 - DK YELLOW-BROWN; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM
	7	35-36.5'			1.3'	SP	35		
							BOH		BOTTOM OF HOLE - 36.5'

AR304726

Signed Robert C. Hackett Date 4/4/86

B-37 Approved I. Krause Date 8 Apr 86

Site INVOW

Boring No. GW-44 SHEET 3 OF 4

WATER USED (GAL)

4/1/86

1900 - ARRIVED AT SITE - POSITIONED RIG

1918 - RAISED DRILLING TOWER

1930 - LEFT SITE FOR DAY

4/2/86

0750 - ARRIVED AT SITE - PREPARED TO BEGIN DRILLING

0804 - DROVE "TEMPORARY" 8" CASING TO START HOLE

0807 - BEGAN DRILLING TO 5' / BAILED HOLE +10/-10

0815 - DROVE SAMPLER 5-6.5' / CABLE TO SAMPLER DRIVER BROKE

0838 - PULLED SAMPLER FROM HOLE

0840 - DRILLED TO 10' / BAILED HOLE +10/-10

0855 - DROVE SAMPLER 10-11.5'

0858 - PULLED TEMPORARY 8" CASING / DROVE 8" CASING TO 15'

0907 - DRILLED TO 15' / BAILED HOLE +10/-20

0919 - DROVE SAMPLER 15-16.5'

0922 - ADDED CASING - WELDED JOINT / DROVE CASING TO 25'

0945 - DRILLED TO 20' / BAILED HOLE +5/-20

0950 - DROVE SAMPLER 20-21.5'

0953 - DRILLED TO 25' / BAILED HOLE +0/-20

0958 - DROVE SAMPLER 25-26.5'

1000 - ADDED CASING - WELDED JOINT / DROVE CASING TO 35'

1015 - DRILLED TO 30' / BAILED HOLE +0/-30

1024 - DROVE SAMPLER 30-31.5'

1027 - DRILLED TO 35' / BAILED HOLE /-30

1042 - DROVE SAMPLER 35-36.5'

1045 - BAILED HOLE / ADDED WATER TO KEEP DOWN SAND +20

1050 - PUT PVC CASING INTO HOLE STARTING W/ 15' SLOT 0.020" SCREEN (10' THEN 5' SECTION) W/ BOTTOM PLUG, THEN 25' OF PVC CASING (2-10' + 1-5' SECTIONS)

1055 - SAND HEAVED UP 2' / PULLED PVC OUT TO BAIL SAND / BAILED HOLE + ADDED WATER +10/-40

1105 - PUT PVC CASING INTO HOLE - SAME AMOUNT + ORDER

1110 - POURED 4 BAGS SAND

1116 - PULLED 8" CASING TO 25' / WASHED, CUT, + REMOVED PIECE

1127 - POURED 3 MORE BAGS SAND

4/2/86 Robert C. Haller
DATE SIGNED

D. Kr[illegible]
APPROVED

Site WPOW
Boring No. GW-44

SHEET 4 OF 4

1132 - Pulled 8" casing to 15' / Washed out + removed piece
1139 - Measured to top sand pack - 15' - Used 7 bags sand
1141 - Poured 1½ buckets bentonite pellets / Pulled 8" casing to top /
Washed + removed piece
1155 - Pour ½ bucket pellets / Measured to top seal - 10' / Poured
10 gals water onto pellets in hole
1200 - Mixed tub grout using - 3 bags cement, ¼ bag quick-gel, 20 gals water
1207 - Poured grout - took ½ tub
1210 - Broke for lunch
1240 - Took off drill bit / Picked up equipment / Prepared
to lower drill tower
1255 - Began lowering drill tower
1310 - Poured rest of grout to top of hole / Washed
equipment + rig
1320 - Cut PVC casing to 2.2' stickup
1325 - Moved rig off site
1330 - Placed protective steel casing over PVC
1345 - Left site

MATERIALS:
15' - 4" PVC screen, sch 40, slot 0.020" (5' + 10' sections)
22.2' - 4" PVC casing, sch 40 (2-10' + 1-5' sections)
7 - 100 lb. bags No. 4 quartz sand
2 - 50 lb. buckets bentonite pellets 3/8"
Grout: 3 - 94 lb. bags Portland Type I cement
¼ - 50 lb. bags quick gel bentonite mud
20 gals water
1 - PVC screw-in bottom plug
1 - PVC slip on top cap

AR304728

4/2/86
DATE

Robert C. Hazlett
SIGNED

DL Kram 8Apr86
APPROVED

AAAP 10/4/86

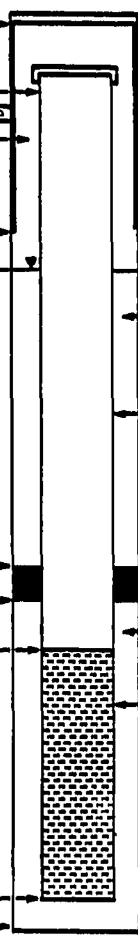
MONITOR WELL CONSTRUCTION

Logged By: Robert Hazlett
Drilling Contractor: Bowser-Morner
Driller's Name: Skaater Patterson
Well Number: GW-44

Client: USATHAMA
Location: WVOW
Job Number: 84604
Date/Time: Start 4/2/86 Finish 4/2/86

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing 2.4'
Top of Well Casing 2.2'
Top of Cement 0'
Bottom of Protective Casing 3.6'
FIRST Ground Water 14'
Top of Bentonite Seal 10'
Top of Gravel Pack 15'
Top of Screen 20'
Bottom of Screen 35'
Total Depth of Bore Hole 36.5'

Locking Cap
Protective Pipe Type, Diameter 6" Steel
Cement/Gravel Pad
Type of Grout Cement/Bentonite 20:1
Casing:
Type PVC Sch 40
Diameter 4"
~~Couplings~~ Joints: Type Flush Threaded
Number 4
Depths 0', 10', 20', 25'
Type of Plug Bentonite Pellets 1/2"
Gravel Pack:
Material No. 4 Quartz Sand
Screen:
Type PVC Sch 40
Diameter 4"
Length 15' (5' + 10' sections)
Slot Size 0.0200"
Bore Hole Diameter 8"

AR304729

NOT TO SCALE

DLKraus 8Apr86

AAAP TOWER

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	North side [illegible] ponds 1+2 [illegible] water [illegible] area
Water Level	[illegible]
Time	1050
Date	3/17/86

Boring No. 45 Date 3/16/86 Sheet 1 of 5

Type of Boring [illegible] Rig [illegible]

Casing used PVC Size 4" Drilling mud used [illegible]

Boring begun 3/16/86 Boring completed 3/17/86

Ground Elevation ______ referred to ______ Datum

Field Party R. Hazlett; [illegible]

Length of Casing Ft.	Sample No.	Sample Depth Interval (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0		
						SC			Sandy clay w/ ~40% fine sand in clay 10YR 4/4 - dk yellow brown; [illegible]; moist; [illegible]; alluvium.
	1	5-6.5'			1.5'	CL	5		Clay w/ sand, silt ~5%; 10YR 4/4 - dk yellow brown; med. to highly plastic; [illegible]; moist; [illegible]; alluvium.
	2	10-11.5'			1.3'	CL	10		Clay w/ some silt or fine sand, [illegible] as above sample in all characteristics except more silt ~10%.
						SP			Poorly graded sand (fine to med.) w/ little clay ~5%. and some fine gravel ~5% [illegible]; 10YR 4/4 - dk yellow brown; not plastic; loose; moist; [illegible]; alluvium
	3	15-16.5'			0.9'	SP	15		Poorly graded sand, same as above sample in all characteristics except sample is dry.
									GRADED Poorly [illegible] sand [illegible] as above except slightly moist & [illegible] a 2" layer of [illegible] at about 21'. This soil is fine [illegible] slightly moist [illegible]
	4	20-21.5'			1.2'	SP	20		

AR304730

Signed Robert C. Hazlett Date 3/16/86

Approved [illegible] Date 8 Apr 86

AAAP 10/485

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVAW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 45 Date 3/16/86 Sheet 2 of 5

Type of Boring ____ Rig ____

Casing used ____ Size ____ Drilling mud used ____

Boring begun ____ Boring completed ____

Ground Elevation ____ referred to ____ Datum

Field Party: ____

Depth of Casing Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									POORLY GRADED SANDS, SAME AS ABOVE SAMPLE IN ALL CHARACTERISTICS.
	5	25-26.5'			1.0	SP	25		
									POORLY GRADED FINE SAND, SAME AS ABOVE SAMPLE BUT SAND SIZE IS FINER + NO GRAVEL PRESENT. A SMALL CLAY LAYER IS PRESENT IN BOTTOM OF SAMPLE (~1/2"). SAMPLE IS DRY.
	6	30-31.5			1.2	SP	30		
									POORLY GRADED SAND SAME AS ABOVE SAMPLE IN ALL CHARACTERISTICS.
	7	35-36.5'			0.8'	SP	35		
									POORLY GRADED SAND, SAME AS ABOVE SAMPLE IN ALL [illegible] NOTE: UPPER FOOT OF SAMPLE IS WET FROM DRILLING WATER, BOTTOM IS DRY.
	8	40-41.5'			1.2'	SP	40		

Signed Robert J. Harlatt Date 3/16/86

Approved DL Krauss Date 8 Apr 86

AR304731

AAAP 10/4/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVPW

Boring No. 45 Date 3/16/86 Sheet 3 of 5

Type of Boring ____ Rig ____

Casing used ____ Size ____ Drilling mud used ____

Boring begun ____ Boring completed ____

Ground Elevation ____ referred to ____ Datum

Field Party: ____

Location of Boring:	
Water Level	
Time	
Date	

Depth of Casing Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	9	45-46.5'			1.5'	SP	45		POORLY GRADED SANDS SAME AS ABOVE SAMPLE EXCEPT SAMPLE IS WET. AND BOTTOM OF SAMPLE IS SOMEWHAT DARKER BROWN THAN TOP OF SAMPLE 10YR 3/3-DK BROWN. AND IT HAS STRINGERS OF BLACK FINE GRAINED SOIL(?).
	10	50-51.5'			1.5'	SP-SC	50		TOP: POORLY GRADED SANDS, W/ SOME CLAY OR SILT ~15% AND SOME FINE GRAVEL ~5% [illegible]; 10YR 3/3-DK BROWN; NOT PLASTIC; LOOSE; WET; [illegible]
						SP			BOTTOM 4": POORLY GRADED SAND SAME AS ABOVE EXCEPT THERE IS LESS CLAY ~5% AND NO GRAVEL. AND COLOR IS [illegible] 10YR 4/4-DK YELLOWISH BROWN
	11	55-56.5'			1.5'	SP	55		POORLY GRADED SAND SAME AS BOTTOM OF ABOVE SAMPLE IN ALL CHARACTERISTICS EXCEPT COLOR, 7.5YR 4/6-STRONG BROWN. SMALL 2" LAYER AT BOTTOM OF SAMPLE HAS [illegible] PERCENT OF [illegible]
									BOTTOM OF HOLE - 56.5'

GROUND WATER SAMPLE WAS ~42'

AR304732

Signed Robert C. Hallett Date 3/16/86

B-43 Approved D. Klaus Date 8Apr86

Site WVDW

Boring No. GW 45

SHEET 4 OF 5

3/16/86 — WATER READINGS

1320 - ARRIVED AT SITE - PREPARED RIG FOR DRILLING
1330 - BEGAN DRIVING HOLE TO 5' / BAILED HOLE +5/-5
1342 - DROVE SAMPLE 5-6.5'
1345 - DROVE HOLE* TO 10' / BAILED HOLE / DROVE 8" CASING TO 8'
1357 - DROVE SAMPLE 10-11.5'
1400 - DROVE CASING* TO 15' / DROVE HOLE TO 15' / BAILED HOLE +4/-4
1415 - DROVE SAMPLE TO 15-16.5'
1420 - DROVE HOLE TO 20' / BAILED HOLE / DROVE CASING TO 20' +5/-5
1425 - DROVE HOLE TO 25' / BAILED HOLE +5/-5
1445 - DROVE SAMPLE 25-26.5'
1450 - DROVE HOLE TO 30' / BAILED HOLE +5/-5
1457 - DROVE CASING TO 25'
1508 - DROVE SAMPLE 30-31.5'
1512 - DROVE HOLE TO 35' / BAILED HOLE +10/-10
1522 - DROVE SAMPLE 35-36.5'
1525 - ADDED CASING - WELDED JOINT / DROVE CASING TO 45'
1550 - DROVE HOLE TO 40' / BAILED HOLE +10/-10
1602 - DROVE SAMPLE 40-41.5'
1605 - DROVE HOLE TO 45' / BAILED HOLE +5/-5
1615 - DROVE SAMPLE 45-46.5'
1620 - ADDED CASING / WELDED JOINT / DROVE CASING TO 50'
1630 - DROVE HOLE TO 50' / BAILED HOLE +10/-10
1640 - DROVE SAMPLE 50-51.5'
1645 - DROVE CASING TO 55' / DROVE HOLE TO 55' / BAILED HOLE +10/-10
1659 - DROVE SAMPLE 55-56.5'
1705 - SHUT DOWN RIG - RAN OUT OF WATER SO QUIT FOR DAY
1715 - LEFT SITE FOR DAY

3/17/86

0730 - BULLDOZER CAME + PULLED WATER TRAILER OUT, DRILLER HAD TO GET MORE CEMENT FROM HARDWARE
0845 - DRILLER ARRIVED W/ CEMENT, WENT TO GET WATER + SUPPLIES
1010 - ARRIVED BACK W/ CEMENT, SUPPLIES, + WATER
1025 - ARRIVED AT SITE - PREPARED TO SET WELL
1040 - BAILED HOLE / DROVE CASING TO ~58' / BAILED HOLE

*"DRIVE HOLE" REFERS TO DRILLING HOLE
"DROVE CASING" REFERS TO [illegible] CASING [illegible] GROUTED TO [illegible]

3/17/86
DATE

Robert [illegible]
ASSIGNED 04733

DLKam 8Apr 86
APPROVED

Site WVOW

Boring No. GW 45

SHEET 5 OF 5

1050 - MEASURED TO BOTTOM OF HOLE, 55.5' - WATER AT 40.5'

1055 - BEGAN SETTING PVC CASING INTO HOLE STARTING W/ 15' OF SLOT 0.0200" SCREEN (5' THEN 10' SECTION) + THEN 45' OF PVC CASING (3-10', 1-5', 1-10' SECTIONS)

1107 - POURED 3 BAGS SAND / PULLED CASING ~3'

1115 - POURED 2 BAGS SAND / PULLED CASING TO ~40' / WASHED CASING

1130 - REMOVED PIECE CASING / POURED 3 BAGS SAND / PULLED CASING TO ~35'

1150 - REMOVED CASING / MEASURED TO TOP OF SAND PACK - 33' - USED 8 BAGS SAND

1155 - POURED 2¾ BUCKETS BENTONITE PELLETS / MEASURED TO TOP OF SEAL - 30'

1200 - PULLED CASING TO ~25' / WASHED CASING / REMOVED CASING

1210 - MIXED TUB OF GROUT USING: 3 BAGS PORTLAND TYPE I CEMENT, ¼ BAG QUIK-GEL AND 25 GALLONS WATER

1220 - POUR 5 GALS WATER INTO BENTONITE PELLETS IN HOLE / POURED GROUT THRU TREMMIE

1227 - MIXED 2ND TUB GROUT - SAME MIX

1235 - PULLED CASING TO ~15' / WASHED CASING / REMOVED CASING

1245 - POURED GROUT / REMOVED REST OF CASING / WASHED CASING

1300 - MIXED 3RD TUB GROUT - SAME MIX / BEGAN PREPARING RIG TO MOVE

1315 - POURED GROUT / CUT OFF TOP OF PVC CASING TO 2.2' ABOVE GROUND

1330 - WASHED DOWN RIG + EQUIPMENT / PACKED RIG TO MOVE

1345 - BEGAN LOWERING DRILL TOWER

1415 - MOVED RIG OFF SITE / PLACED PROTECTIVE CASING + CAP ON PVC CASING

3/18/86 - TOPPED OFF GROUT IN HOLE

MATERIALS:

15' PVC SCREEN, SCH 40, 4" DIA, SLOT 0.0200" (5' + 10' PIECES)

40.2' PVC CASING, SCH 40, 4" DIA.

1 SCREW-IN BOTTOM PLUG (PVC); 1 SLIP-ON TOP CAP (PVC)

8 - 100 lb BAGS No. 4 QUARTZ SAND

2¾ - 50 lb BUCKETS 3/8" BENTONITE PELLETS

GROUT: 9 - 94 lb. BAGS PORTLAND TYPE I CEMENT

¾ - 50 lb BAG QUIK-GEL BENTONITE MUD

75 GALS WATER

0 GALS WATER LOST IN HOLE DURING DRILLING

3/17/86 — DATE

Robert C. [illegible] — SIGNED

DL Kram 8Apr86 — APPROVED

AR304734

AAAP 10/4/83

MONITOR WELL CONSTRUCTION

Logged By: Robert C. Hewlett [illegible]

Drilling Contractor: [illegible]

Driller's Name: [illegible]

Well Number: GW-45

Client: USATHAMA

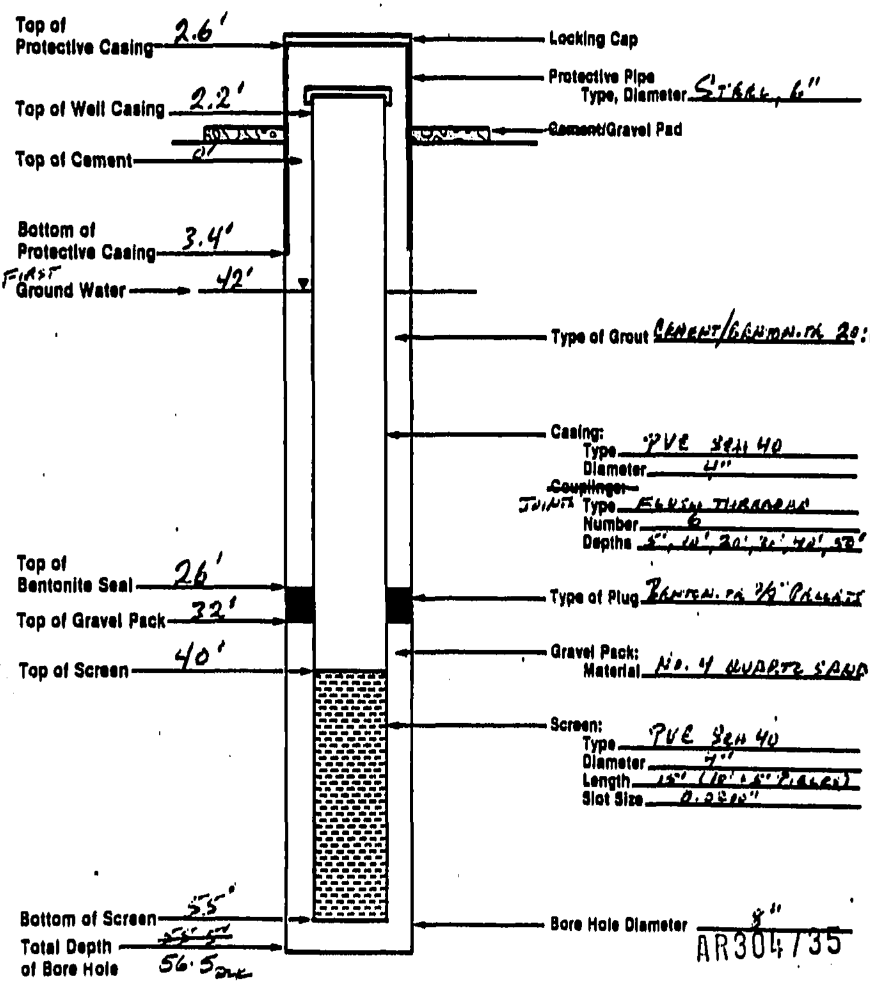
Location: [illegible]

Job Number: 84604

Date/Time: Start 3/16/86 Finish 3/17/86

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



AR304735

NOT TO SCALE

DL Kraus 8Apr86

AAAP 10466

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604-0800
Client USATHAMA
Project LUVOLU

Location of Boring:	North side between Ponds 1+2 Bad Water Reservoir Area
Water Level	[illegible]
Time	
Date	

Boring No. 45D Date 3/13/86 Sheet 1 of 11
Type of Boring Monitor Well Rig Cable-tool
Casing used PVC Size 4" Drilling mud used NONE
Boring begun 3/13/86 Boring completed 3/14/86
Ground Elevation ______ referred to ______ Datum
Field Party: R. Hazlett, [illegible]

Depth of Casing Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0		Fine sand w/trace [illegible]; not plastic; brown; wet; alluvium
						SC			Fine sand + clay w/~60% fine sand and 40% clay; 10YR 4/4 dk yellow brown; slightly plastic; loose; wet; NAR; alluvium
	1	5-6.5'			1.5'		5		
						CL			Clay w/small amount silt or fine sand; ~90% clay ~10% silt w/ fine sand; 10YR 4/6 dk yellow brown; highly plastic; loose; wet; NAR; alluvium
	2	10-11.5'			1.5'	SC	10		Fine sand w/some clay, ~80% clay and 15% silt; 10YR 4/4 dk yellow brown; low plastic; loose; wet; NAR; alluvium
						SP			*Bottom 2" of sample is med. sand w/less clay, ~5% clay; same color; low plast.; loose; moist; NAR; alluvium
	3	15-16.5'			1.0'	SP	15		Fine to med. sand, poorly graded w/little clay ~5% clay w/o silt; 10YR 4/4 dk yellow brown; not plastic; loose; slightly moist; NAR; alluvium
	4	20-21.5'			1.0'	SW-SM	20		Well graded sands ~5% clay ~5% silt, ~30% fine sand, ~50% med. sand, [illegible] gravel [illegible]; 10YR 4/4 dk yellow [illegible]

Possible fines due to rain

AR304736

Signed Robert C. Hazlett Date 3/13/86
Approved [signature] Date [illegible]

AAAP 10465

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USA THAMA

Project UVOW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 45D Date 3/13/86 Sheet 2 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									NOT PLASTIC; LOOSE, SLIGHTLY MOIST; NAR; ALLUVIUM. SAMPLE DARKER AND SLIGHTLY COARSER AT BOTTOM.
	5	25-26.5'			1.2'	SW-SM	25		WELL GRADED SANDS; ~10% SILT, ~20% FINE SAND, ~60% MED SAND, ~10% GRAVEL; 10YR 4/4-DK YELLOW BROWN; NOT PLASTIC; LOOSE; SLIGHTLY MOIST; NAR; ALLUVIUM.
	6	30-31.5'			1.5'	SW-SM	30		WELL GRADED SANDS - SAME AS ABOVE SAMPLE BUT ONLY ~5% GRAVEL; ALL OTHER CHARACTERISTICS SAME AS ABOVE, EXCEPT ABOUT A 2" LAYER AT ~31' WHICH IS SLIGHTLY DARKER AND MOISTER THAN REST OF SAMPLE.
	7	35-36.5'			1.2'	SM	35		POORLY GRADED SAND W/ ~10% SILT; 5% CLAY, 80% FINE-MED SAND, 5% GRAVEL (FINE) - AMOUNT OF GRAVEL DECREASES TO ALMOST NONE AT BOTTOM OF SAMPLE; 10YR 4/4-DK YELLOW BROWN; NOT PLASTIC; LOOSE; TOP OF SAMPLE MOIST POSSIBLY FROM WATER ADDED, BOTTOM OF SAMPLE V. SLIGHTLY MOIST; NAR; ALLUVIUM.
	8	40-41.5'			1.0'	SP-SM	40		POORLY GRADED SAND W/ ~10% SILT ~85% FINE-MED SAND ~5% GRAVEL (FINE); 10YR 4/4 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; WET, NAR

SAMPLE WET. WATER TABLE ~40'

Signed Robert C. Hazlett Date 3/13/86

Approved D. Klaus Date 8 Apr 86

AAAP 10460

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 45D Date 3/13/86 Sheet 3 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	9	45-46.5'			1.1'	SP-SM	45	POORLY GRADED SAND, SAME AS ABOVE SAMPLE EXCEPT VERY LITTLE GRAVEL ~1%. ALL OTHER CHARACTERISTICS SAME AS ABOVE SAMPLE.
						SP-SM		POORLY GRADED SAND SAME AS ABOVE SAMPLE IN ALL CHARACTERISTICS.
	10	50-51.5'			1.5'	SM	50	WELL GRADED SANDS W/ ~20% SILT, ~80% FINE SAND; 10YR 4/6 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; MOIST; NAR; ALLUVIUM
						SC		WELL GRADED SAND W/ MORE CLAY THAN ABOVE SAMPLE ~30% CLAY, ~10% SILT, ~60% FINE SAND; 5YR 4/6 - YELLOWISH RED; SLIGHTLY PLASTIC; LOOSE; WET; SOME BEDDING PRESENT (COLORATION); ALLUVIUM.
	11	55-56.5'			1.5'	SP	55	POORLY GRADED SAND W/ ~5% SILT ~95% FINE SAND; 10YR 4/4 - DK YELLOW BROWN AND 10YR 4/1 - DK GRAY LAYER ABOUT 3" WIDE AT 55.5'; NOT PLASTIC; LOOSE; MOIST; ALLUVIUM.
						CH		-SMALL 3" LAYER OF GRAVELLY SAND W/ ~20% GRAVEL AT BOTTOM OF SAMPLE, DK GRAY, NOT PLASTIC; MOIST. -VERY BOTTOM OF SPOON CONTAINED FAT CLAY; 10YR 5/1 - GRAY; HIGHLY PLASTIC; LOOSE; MOIST; NAR; ALLUVIUM
	12	60-61.5'			1.5'	CH	60	FAT CLAY W/ NO SAND BUT FOUND ONE LARGE PIECE ROUNDED GRAVEL IN TOP OF SAMPLE; 10YR 5/1 - GRAY; HIGHLY PLASTIC; HARD, DENSE; SLIGHTLY MOIST; NAR; ALLUVIUM.

AR304738

Signed [illegible] Date 3/13/86

 Approved [illegible] Date 8 Apr 86

AAAP 10468

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Location of Boring:

Water Level	
Time	
Date	

Boring No. 45D Date 3/13/86 Sheet 4 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______

______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth from-to ft.	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							64		FAT, GRAY CLAY AT TOP OF SAMPLE SAME AS ABOVE SAMPLE.
	13	65-66.5'			.5'	CH			BELOW THIS IS 3" OF GRAVELLY CLAY W/ ~20% GRAVEL AND SAND, ~80% CLAY; THIS GRADES INTO A MORE PURE CLAY W/ ~10% SILT OR FINE SAND; THESE TWO LAYERS ARE A MOTTLED BLUE AND 5Y3/2 - DK. OLIVE GRAY; WHOLE SAMPLE IS HIGHLY PLASTIC; MED. DENSE; SLIGHTLY MOIST; NAB; ALLUVIUM
						CL	66		
	14	70-71.5'			1.5'	CL	70		INTERBEDDED CLAY AND SANDY CLAY; CLAY HAS SOME SILT (~5%) AND IS 10YR 5/1 - GRAY; HIGHLY PLASTIC; MED. DENSE; SLIGHTLY MOIST; ALLUVIUM. SANDY CLAY HAS ~25% FINE SAND; 5YR 4/4 - REDDISH BROWN; MED. PLASTIC; LOOSE; MOIST; ALLUVIUM. SANDY CLAY MORE PREVALENT IN SAMPLE W/ 1 ~3" LAYERS OF GRAY CLAY.
	15	75-76.5'			1.5'	SC	75		CLAY-SANDS W/ ~70% FINE SANDS AND ~15% CLAY; 10YR 4/4 - DK YELLOW BROWN; SLIGHTLY PLASTIC; LOOSE; MOIST; NAB; ALLUVIUM.
						CL			BOTTOM 10" OF SAMPLE IS CLAY W/ SOME FINE SAND ~10%; 10YR 4/3 - BROWN; HIGHLY PLASTIC; MED. DENSE; MOIST; SOME SMALL RED-BROWN LAYERS PRESENT (~1/2"); ALLUVIUM.
						SC	SC 80		
	16	80-81.5'			1.5	CL	CL		TOP 4" CLAYEY SAND W/ ~60% FINE-MED SAND, ~30% SILT AND ~5% GRAVEL; THERE IS A SMALL SEAM OF BLACK PARTICLES [illegible] AT BOTTOM; 5Y 4/2 - [illegible]; NOT PLASTIC; LOOSE; MOIST; NAB [illegible]; ALLUVIUM.
						SC	SC		MIDDLE 1' - INTERBEDDED CLAY & SANDY CLAY W/ ~20% FINE SAND; CLAY IS 5Y [illegible] SLIGHTLY PLASTIC; MED. DENSE; SLIGHTLY MOIST; ALLUVIUM
							SP SM 85		BOTTOM 6" CLAYEY SAND, SAME AS TOP OF SPOON BUT WITHOUT BLACK (COAL?) PARTICLES [illegible] CLAY LAYER, ALL OTHER CHARACTERISTICS SAME.

Signed Robert C. [illegible] Date 3/15/86

Approved D. Krum Date 8 Apr 86

AR304739

AR304739

S.S. - SANDSTONE

AAAP 10/485

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84644

Client USATHAMA

Project WVRW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 45D Date 3/15/86 Sheet 5 of 11

Type of Boring ________ Rig ________

Casing used ______ Size ______ Drilling mud used ______

Boring begun ________ Boring completed ________

Ground Elevation ________ referred to ________ Datum

Field Party: ________

Depth of Casing Ft.	Sample No.	Sample Depth from __ to __ Feet	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							85		POORLY GRADED SAND w/~90 FINE TO MED. SAND ~10% SILT; 5Y 4/2 - OLIVE GRAY; NOT PLASTIC; LOOSE; WET; ~1/4" BLACK [illegible] LAYER; POSSIBLY [illegible] PARTICLES IN [illegible] PART OF SAMPLE; ALLUVIUM
	17	85-86.5'			1.4'	SP-SM			
							88		24"
						CL			CLAY W/LITTLE SAND ~10% FINE SAND; 5Y 4/1 - DK. GRAY; HIGHLY PLASTIC; MED. DENSE; MOIST; NAB; ALLUVIUM
	18	90-91.5'			1.2'	SP-SM/CL	90		5" INTERBEDDED CLAYEY-SAND [illegible] CLAY, SAND HAS LITTLE CLAY ~10%; CLAY [illegible]; SAND IS 5Y 4/2 - OLIVE GRAY, CLAY IS SAME AS ABOVE CLAY IN CHARACTER; SAND IS NOT PLASTIC; LOOSE, MOIST, NAB, ALLUVIUM.
						SP-SM			BOTTOM OF SAMPLE IS [illegible] SAND [illegible] EASILY CRUMBLES, POORLY SORTED SAND (FINE-MED. SIZE); 2.5Y 7/1 - LT. GRAY; SLIGHTLY MOIST; [illegible] THE [illegible] CLAYEY-SAND AS ABOVE, THIS SAND IS WET.
	19	95-96.5'			1.3'	SP-SM	95		FINE SAND; POORLY GRADED SAND W/LITTLE CLAY ~10% SILT; 5Y 4/2 - OLIVE; NOT PLASTIC; MED. DENSE; SMALL LAYER OF CLAY PRESENT IN BOTTOM OF SAMPLE (~1/4"); ALLUVIUM; WET. [illegible] FOUND IN BOTTOM OF SAMPLE, MAY HAVE DRIVEN SPLIT SPOON THROUGH BOULDER, POSSIBLY FINE GRAINED SANDSTONE.
	20	100-101.5'			1.5'	SP-SM	100		BAILER BROUGHT UP CHUNKS OF [illegible] SANDSTONE ([illegible]) AT 98', WELL-CEMENTED. THIS S.S. MAY HAVE BEEN [illegible] UP FROM DEEPER.
	21	102.5-105'			1.3'	SP-SM	103		POORLY GRADED SAND (FINE) W/LITTLE SILT ~10%; 5Y 4/2 - OLIVE GRAY; NOT PLASTIC; [illegible] BOTTOM HALF OF SAMPLE HAS 4"-12" CLAY LAYERS; THIS CLAY IS PURE NO SAND, 5Y 4/1 - DK. GRAY; HIGHLY PLASTIC; SLIGHTLY MOIST; ALLUVIUM. [illegible] COARSE GRAVEL PRESENT THROUGHOUT SAMPLE
	(SEE NEXT PAGE FOR DESCRIPTION OF SAMPLE #21)						105		NSZA

Signed Robert C. Hazlett Date 3/15/86

Approved D. Krau Date 8 Apr 86

AR304740

AAAP 10468

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 45A Date 3/15/86 Sheet 6 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							105		A LOT OF WELL ROUNDED COARSE GRAVEL BEING BROUGHT UP BY BAILER, POSSIBLY HEAVED UP W/SAND FROM DEEPER. SAMPLE #21 POORLY GRADED SAND (FINE) W/LITTLE SILT ~10%, AND SOME FINE GRAVEL ~5% WHICH IS WELL ROUNDED; 5Y 4/2 - DK GRAY; NOT PLASTIC; LOOSE; WET; NAB; ALLUVIUM. - NOTE: SOME FLAT-ROCKS PRESENT IN SAMPLE BUT NOT IN LAYERS. BOTTOM OF HOLE - 106.5'

AR300741

Signed Robert C. Hazlett Date 3/15/86

Approved D. Kraus Date 8Apr86

Site WVOW

Boring No. GW 45-D

SHEET 7 OF 11

3/13/86 WATER GAIN/LOSS

1015 - ARRIVED AT SITE - BEGAN SETTING-UP TO DRILL

1110 - BEGAN DRIVING HOLE	+10	+2
1115 - BAILED HOLE	-8	
1118 - DROVE SAMPLE 5-6.5'		
1125 - DROVE HOLE*	+7	
1130 - BAILED HOLE	-7	
1133 - ADDED CASING (10'3¾"), DROVE IT IN		
1140 - DROVE SAMPLE 10-11.5'		
1143 - DROVE HOLE	+10	+5
1150 - BAILED HOLE	-5	
1154 - ADDED CASING (8'9"), DROVE IT IN		
1203 - CLEANED OUT HOLE TO 15'	+3/-8	-5
1206 - DROVE SAMPLE 15-16.5'		
1209 - DROVE HOLE	+7	
1212 - BAILED HOLE	-7	
1215 - DROVE HOLE		
1218 - BAILED HOLE	-1	-1
1220 - DROVE SAMPLE 20-21.5'		
1222 - ADDED CASING (7'11¾"), DROVE IT IN		
1226 - DROVE HOLE	+5	0
1229 - BAILED HOLE	-5	
1232 - DROVE HOLE / BAILED HOLE	+5/-5	0
1238 - DROVE SAMPLE 25-26.5'		
1240 - DROVE HOLE / BAILED HOLE	+15/-10	+5
1250 - DROVE SAMPLE 30-31.5'		
1255 - BROKE FOR LUNCH		
1325 - DROVE HOLE	+10	+10
1330 - ADDED CASING (9'11½")		
1341 - DROVE HOLE / DROVE CASING / BAILED HOLE	+10/-20	-10
1351 - DROVE HOLE / DROVE CASING / DROVE HOLE / BAILED	-5	-5
1359 - DROVE SAMPLE - 35-36.5'		
1402 - DROVE HOLE		
1410 - ADDED CASING (8'7¾"), WELDED JOINT		

AR304742

*"Driven Hole" refers to [illegible] drill.

3/13/86
DATE

Robert C. Hazlett
SIGNED

D. Kraus 8Apr86
APPROVED

Site WVOW
Boring No. GW-45D

SHEET 8 OF 11

	WATER USED (GALS)
1436 - DROVE CASING / DROVE HOLE	+5
1440 - HAD PROBLEM W/ CLUTCH CABLE	
1455 - BAILED HOLE / DROVE HOLE / BAILED HOLE	-5/+4/-5
1502 - DROVE SAMPLE - 40-41.5'	
1504 - DROVE CASING / DROVE HOLE / BAILED HOLE	+4/-6
1517 - DROVE SAMPLE - 45-46.5'	
1520 - DROVE HOLE	+5
1525 - ADDED CASING (9'11"), WELDED JOINT	
1540 - DROVE CASING / BAILED HOLE	-10
1550 - DROVE HOLE / BAILED HOLE	+4/-8
1555 - DROVE SAMPLE - 50-51.5'	
1600 - DROVE HOLE / DROVE CASING / BAILED HOLE	+5/-5
1617 - DROVE SAMPLE 55-56.5'	
1620 - DROVE HOLE / DROVE CASING / BAILED HOLE	+5/-5
1640 - DROVE SAMPLE - 60-61.5'	
1642 - DROVE HOLE / DROVE CASING / BAILED HOLE	+5/-5
1654 - DROVE SAMPLE - 65-66.5'	
1656 - DROVE HOLE	
1700 - ADDED CASING (12'8"), WELDED JOINT	
1720 - DROVE CASING	
1730 - DROVE HOLE / BAILED HOLE / DROVE HOLE / BAILED	0/-15/0/-10
1745 - DROVE SAMPLE - 70-71.5'	
1748 - DROVE HOLE / BAILED HOLE / DROVE HOLE / BAILED	0/-10/+5/-20
1807 - DROVE SAMPLE - 75-76.5'	
1810 - ADDED CASING (10'5"), WELDED JOINT	
1825 - DROVE CASING	
1833 - BAILED HOLE / CLEARED HOLE BACK DOWN TO 75'	
1845 - DROVE CASING DOWN TO 77'	
1850 - LEFT SITE FOR DAY	
3/14/86	
0810 - ARRIVED AT SITE - WARMED UP RIG TO START DRILLING - PROBLEMS W/ VEHICLES STUCK IN MUD	
0835 - BAILED HOLE - FILLED W/ SAND + WATER	
0845 - DROVE HOLE / BAILED HOLE	

WATER SEALED IN THE SAND BEFORE CASING DRIVEN DOWN BELOW IT

WATER SEALED UNDER CASING

AR304743

3/14/86 — DATE

Robert C. Hazlett — SIGNED

D. Kraus 8 Apr 86 — APPROVED

Site UVOW
Boring No. GW-45D

SHEET 9 OF 11

0848 - DROVE SAMPLE 80-81.5' · WATER VISIBLE
0900 - QUIT DUE TO RAIN
0945 - LEFT SITE TO WAIT OUT RAIN
3/15/86
0745 - ARRIVE AT SITE, BEGIN PREPARING TO DRILL
0755 - BAILED HOLE
0800 - DROVE HOLE / BAILED HOLE
0811 - DROVE SAMPLE 85'-86.5'
0815 - ADDED CASING (11'1"), WELDED JOINT
0830 - DROVE CASING
0840 - DROVE HOLE / BAILED HOLE
0853 - DROVE CASING / DROVE HOLE / BAILED HOLE
0904 - DROVE SAMPLE - 90-91.5'
0909 - DROVE HOLE / BAILED HOLE
0930 - ADDED CASING (6'10¾"), WELDED JOINT
0947 - DROVE CASING
0950 - DROVE HOLE / BAILED HOLE
1001 - DROVE SAMPLE 95-96.5'
1005 - DROVE HOLE / BAILED HOLE / DROVE HOLE / BAILED HOLE
1025 - ADDED CASING (10'4½"), WELDED JOINT
1040 - DROVE CASING / BAILED HOLE 130/-80
1056 - DROVE HOLE / BAILED / DROVE HOLE / BAILED +15/-20
1115 - DROVE SAMPLE 100-101.5'
1120 - DROVE HOLE / BAILED HOLE
1135 - CUT PIECE OF CASING
1150 - ADDED CASING (5'3"), WELDED JOINT
1205 - DROVE CASING / BAILED HOLE
1222 - DROVE SAMPLE - 103.5-105'
1227 - DROVE HOLE / BAILED HOLE
1245 - MEASURED TO BOTTOM OF HOLE - 106'
1250 - BREAK FOR LUNCH
1320 - BAILED HOLE
1330 - MEASURED TO BOTTOM OF HOLE - 106.5'
1331 - BEGAN PUTTING PVC CASING DOWN HOLE - START W/ 10' OF
SLOT 0.0200" SCREEN, SCH 40, 4" DIA., W/ BOTTOM PLUG

AR304744

3/15/86
DATE

ROBERT C. HAZLETT
SIGNED

D. Kraus 8 Apr 86
APPROVED

QG = QUIKGEL

Site WVOW

Boring No. GW-45D

SHEET 10 OF 11

1335 - BEGAN PLACING PVC CASING (SOLID) DOWN HOLE - 95' OF
SCH 40, 4" DIA. - BOTTOM AT 106', 4' STICKING-UP
1400 - BEGAN POUR SAND PACK (No. 4 QUARTZ) - POURED 3 BAGS (100 lbs)
1406 - PULLED CASING (8")
1422 - ADDED 1 BAG SAND / PULLED CASING
1435 - PRESSURE WASHED CASING + CUT IT W/TORCH & REMOVED PIECE
1440 - ADDED 3 BAGS OF SAND / PULLED CASING
1453 - WASHED CASING / CUT CASING
1504 - ADDED 1 BAG SAND - TOTAL: 8 BAGS SAND - TOP AT 83.5'
1510 - BEGAN MIXING TUB OF GROUT USING: 2-94 lb. BAGS TYPE I
PORTLAND CEMENT + 1/4-50 lb BAG QUIKGEL BENTONITE MUD + 20 GALS WATER
1525 - PULLED CASING
1531 - POURED 2 - 50 lb BUCKETS 3/8" BENTONITE PELLETS
1534 - PULLED CASING / WASHED CASING / CUT CASING
1545 - MEASURED TOP OF BENTONITE - 77½' - POURED GROUT USING TREMIE PIPE
1558 - MIXED 2ND TUB GROUT: 3 BAGS CEMENT, 1/4 BAG Q.G., 20 GALS WATER
1605 - POUR GROUT
1612 - MIXED 3RD TUB GROUT: SAME MIX / POURED GROUT
1625 - PULLED CASING / WASHED CASING / CUT CASING
1640 - PULLED CASING / WASHED CASING / CUT CASING
1654 - MIXED 4TH TUB GROUT: SAME MIX
1703 - PRESSURE WASHER RAN OUT OF GAS
1709 - MIXED GROUT (4TH TUB) / POURED GROUT
1720 - MIXED 5TH TUB GROUT - SAME MIX / POURED GROUT
1738 - MIXED 6TH TUB GROUT - SAME MIX
1755 - PULLED CASING / WASHED CASING / CUT CASING
1802 - PULLED CASING / WASHED IT / CUT IT
1810 - PULLED CASING / WASHED IT / UNSCREWED IT
1817 - MIXED 7TH TUB GROUT - SAME MIX / POURED GROUT
1835 - RAN OUT OF WATER & CEMENT - NEED BULLDOZER
TO MOVE WATER TRAILER & IT IS NOT AVAILABLE - CASING
IS ABOVE GROUT LEVEL SO DECIDED TO FINISH IN MORNING
1850 - LEFT SITE FOR DAY
3/16/86

AR304745

0730 - ARRIVED AT SITE - BULLDOZER TOOK OUT WATER TRAILER TO GET FILLED

3/18/86 — DATE

Robert C. Hazlett — SIGNED

DL Kraus 8 Apr 86 — APPROVED

Site WVOW
Boring No. GW-45D

SHEET 11 OF 11

0930 - RETURNED TO SITE W/WATER + MORE CEMENT - PREPARED
TO COMPLETE GROUTING
0945 - MIXED 8TH TUB GROUT / POURED GROUT
1005 - MIXED 9TH TUB GROUT - SAME MIX / POURED GROUT
1018 - MIXED 10TH TUB GROUT - SAME MIX / POURED GROUT
1027 - MIXED 11TH TUB GROUT - SAME MIX / POURED GROUT
1040 - RAN OUT OF CEMENT, HAD TO GO GET MORE
1115 - RETURNED W/CEMENT - MIXED 12TH TUB GROUT - SAME MIX / POURED GROUT
1130 - MIXED 13TH TUB GROUT - SAME MIX / POURED GROUT
1136 - PULLED CASING / WASHED CASING / REMOVED IT
1144 - MIXED 14TH TUB GROUT - SAME MIX / POURED GROUT
1200 - MIXED 15TH TUB GROUT - SAME MIX
1209 - PULLED CASING / WASHED CASING / REMOVED FINAL PIECE CASING
1220 - MIX TUB GROUT TO TOP OFF, USE: 2 BAGS CEMENT, 1/10 BAG QG, +
15 GAL WATER / POURED GROUT
1230 - BROKE FOR LUNCH
1305 - PREPARED RIG TO MOVE OFF SITE / MOVED RIG
1330 - CUT OFF PVC CASING TO 2.2' ABOVE GROUND
1340 - PLACED PROTECTIVE STEEL CASING + PVC CAP ON CASING
3/17/86
· TOPPED OFF GROUT AROUND PROTECTIVE CASING

MATERIALS:
15' PVC SCREEN SCH 40, 4" DIA. SLOT 0.020" (5' + 10' SECTIONS)
93.2' PVC CASING, SCH 40, 4" DIA. (9 - 10' + 1 - 5' SECTIONS)
1 PVC SCREW-IN BOTTOM PLUG, 1 PVC SLIP-ON CAP
8 - 100 lb. BAGS No. 4 QUARTZ SAND
2 - 50 lb BUCKETS 3/8" BENTONITE PELLETS
GROUT: 46 - 94 lb. BAGS PORTLAND TYPE I CEMENT
3 3/4 - 50 lb. BAGS QUIK GEL BENTONITE MUD
450 GALS WATER

AR304746

0 GALS LOST IN HOLE DURING DRILLING

3/16/86 — DATE
Robert C. [illegible] — SIGNED

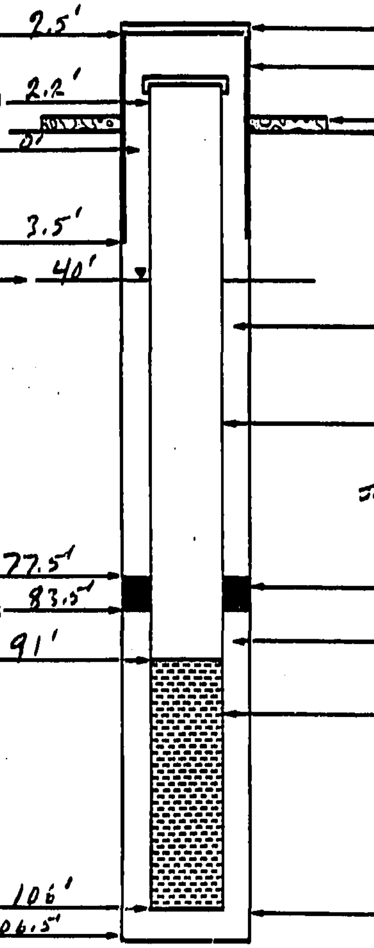
DL Krause 8Apr86 — APPROVED

AAAP 10/4/85

MONITOR WELL CONSTRUCTION

Logged By: Robert C. Hazlett
Client: USATHAMA
Drilling Contractor: [illegible]
Location: WVOW
Driller's Name: [illegible]
Job Number: 84604
Well Number: GW-45D
Date/Time: Start 3/13/86 Finish 3/16/86
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing 2.5'
Locking Cap
Protective Pipe Type, Diameter Steel, 6"
Top of Well Casing 2.2'
~~Cement~~/Gravel Pad
Top of Cement 0'
Bottom of Protective Casing 3.5'
First Ground Water 40'
Type of Grout Cement/Bentonite [illegible]
Casing: Type PVC sch. 40
Diameter 4"
~~Couplings:~~ Joint Type Flush threaded
Number 11
Depths 6', 11', 21', 31', 41', 51', 61', 71', 81', 91', 96'
Top of Bentonite Seal 77.5'
Type of Plug Bentonite "A" [illegible]
Top of Gravel Pack 83.5'
Top of Screen 91'
Gravel Pack: Material No. 4 quartz sand
Screen: Type PVC sch 40
Diameter 4"
Length 15' (5' + 10' sections)
Slot Size 0.020"
Bottom of Screen 106'
Total Depth of Bore Hole 106.5'
Bore Hole Diameter 8"

AR304747

NOT TO SCALE

Robert C. Hazlett
3/16/86

De Kraus

AAAP 10/4/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	About 500 yards North of Ponds 1 & 2 - [illegible] Residential Area
Water Level	First water - 34'
Time	1800
Date	3/17/86

Boring No. 46 Date 3/17/86 Sheet 1 of 6

Type of Boring [illegible] Rig [illegible]

Casing used PVC Size 4" Drilling mud used none

Boring begun 3/17/86 Boring completed 3/18/86

Ground Elevation ______ referred to ______ Datum

Field Party: R. Hazlett, [illegible] & [illegible] Patterson

Depth of Casing, Ft.	Sample No.	Sample Depth (from-to, in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		Sandy-clay w/~20% sand; brown; med. plastic; soft; slightly moist; alluvium.
	1	5-6.5'			1.5'	SP	5		Poorly graded fine sand w/little silt ~5%; 10YR 4/4 - dk yellow brown; not plastic; loose; v. slightly moist. [illegible] distinguished by color present; alluvium.
	2	10-11.5'			1.5'	CL/SC	10		Interbedded clay layers w/little sand ~5% and clayey sand layers w/~15% clay + silt; [illegible] 4/4 - dk yellow brown; clay is highly plastic; sand is low plasticity; both loose; moist; alluvium.
						SP			Poorly graded fine to med. sand w/ little silt ~10% and some fine gravel ~5%, [illegible] rounded; 10YR 4/4 - dk yellow brown; not plastic; loose; v. slightly moist, NAB; alluvium.
	3	15-16.5'			1.0'	SP	15		Poorly graded fine to med sand w/little silt ~5% and some fine to coarse [illegible] gravel ~15%; 10YR 5/4 - yellow brown; not plastic; loose; v. slightly moist; NAB; alluvium.
	4	20-21.5'			1.0'	SP	20		Poorly graded fine sand w/little silt ~5%; 10YR 5/4 - yellow brown; not [illegible]; loose; dry; some bedding present as light & dark layers & one small (1/4") black layer of soil (organics?); fine grained; alluvium.

Signed Robert C. Hazlett Date 3/17/86

Approved D. Kra[illegible] Date 8 Apr 86

AR304748

AAAP 10/486

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	39' (5' WATER DRILLING)
Time	1740
Date	3/17/86

Boring No. 46 Date 3/17/8_ Sheet 2 of 6

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______

______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									POORLY GRADED FINE SAND W/LITTLE SILT ~5% AND LITTLE FINE GRAVEL ~3%; 10YR 4/4 - DK YELLOW BROWN NOT PLASTIC; LOOSE; DRY; NAR; ALLUVIUM.
	5	25-26.5'			1.2'	SP	25		
									POORLY SORTED FINE SAND W/LITTLE SILT ~5%; 10YR 4/4 - DK YELLOW BROWN; NOT PLASTIC; LOOSE; DRY; SMALL LAYER (1/4") OF [illegible] FINE GRAVEL [illegible] AT ~31'; ALLUVIUM.
	6	30-31.5'			1.2'	SP	30		
									POORLY GRADED FINE SAND W/LITTLE SILT ~5 AND SOME FINE [illegible] GRAVEL ~15% IN UPPER PART OF SAMPLE; 10YR 4/4 - DK YELLOW BROWN; NOT PLASTIC; MED DENSE; SLIGHTLY MOIST; NAR; ALLUVIUM
	7	35-36.5'			1.5'	SP	35		
									POORLY GRADED FINE SAND W/LITTLE SILT ~5% AND LITTLE FINE GRAVEL ~5%; 10YR 3/3 - DK BROWN; NOT PLASTIC; LOOSE; WET; [illegible] LAYER OF GRAVEL PRESENT AT ~40.5'; ALLUVIUM
	8	40-41.5'			1.5'	SP	40		

HIT WATER SAMP. WET AT ~39'

AR304749

Signed Robert C. [illegible] Date 3/17/86

Approved D. L. Kraus Date 8 Apr 86

AAAP 104/66

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project W[illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 46 Date 3/17/86 Sheet 3 of 6

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									Poorly graded fine sand w/little silt ~5% + [illegible] fine gravel ~5% and one small clay lense; 10YR 3/[illegible] dk brown; non plastic; loose; wet; NAB; alluvium.
	9	45-46.5'			1.5'	SP	45		Interbedded clay + clayey sand layers. Clay layer have little sand ~10% and sand layers have some clay, ~20-35%. There is fine [illegible] gravel throughout; 10YR 3/[illegible] - dk brown; clay is highly plastic, sand is low to non plastic; loose; wet; alluvium.
						CL/SC			
	10	50-51.5'			1.5'	SP	50		Poorly graded fine sand w/little silt ~5% + little fine gravel ~[illegible]%; 10YR 3/3 - dk brown; non plastic; loose; wet; NAB; alluvium.
	11	55-56.5'			1.5'	SP	55		Poorly graded fine sand w/little silt ~5% and some fragments of gray sandstone ~2%; 10YR 4/4 - dk yellowish brown; non plastic; loose; wet; NAB; alluvium.
							60		Bottom of Hole - 56.5'

AR304750

Signed Robert C. Hazlett Date 3/19/86

Approved Dr. Kraus Date 8 Apr 86

Site WVOCW
Boring No. GW-46

SHEET 4 OF 6

3/17/86 — WATER USED (GALS)

1435 - ARRIVED AT SITE, POSITIONED RIG
1445 - PULLED WATER TRAILER IN TO SITE
1450 - BROKE FOR LUNCH
1520 - BEGAN SETTING-UP RIG TO DRILL
1550 - BEGAN DRILLING HOLE TO 5' / BAILED HOLE
1558 - DROVE SAMPLE TO 5-6.5' — +10/-10
1600 - DROVE HOLE* TO 10' / BAILED HOLE — +5/-5
1610 - DROVE SAMPLE 10-11.5'
1612 - DROVE CASING** TO 15' / DROVE HOLE TO 15' / BAILED HOLE — +5/-5
1625 - DROVE SAMPLE 15-16.5'
1627 - DROVE CASING TO 20' / DROVE HOLE TO 20' / BAILED HOLE — +5/-5
1634 - DROVE SAMPLE 20-21.5'
1636 - DROVE CASING TO 26' / DROVE HOLE TO 25' / BAILED HOLE — +10/-10
1657 - DROVE SAMPLE 25-26.5'
1700 - DROVE CASING (TO 11") TO ~34' / DROVE HOLE TO 30' / BAILED HOLE — +5/-5
1722 - DROVE SAMPLE 30-31.5'
1725 - DROVE HOLE TO 35' / DROVE CASING (6") TO ~40' / BAILED HOLE — +5/-5
1740 - DROVE SAMPLE 35-36.5'
1744 - DROVE HOLE TO 40' / BAILED HOLE — +5/-5
1758 - DROVE SAMPLE 40-41.5'
1801 - DROVE CASING TO 44' / DROVE HOLE TO 45' / BAILED HOLE — +5/-5
1815 - DROVE SAMPLE 45-46.5'
1818 - DROVE CASING TO 54' / DROVE HOLE TO 50' / BAILED HOLE — +5/-5
1841 - DROVE SAMPLE 50-51.5'
1845 - SHUT DOWN RIG
1850 - LEFT SITE FOR DAY

3/18/86

0730 - ARRIVED AT SITE - PREPARED TO MOVE WATER TRAILER OUT TO GET MORE WATER
0800 - MOVED WATER TRAILER OUT / CUT SHORT PIECE OF CASING TO COMPLETE CASING IN HOLE
0810 - ADDED CASING / WELDED JOINT / DROVE CASING TO 55'
0825 - DROVE HOLE TO 55' / BAILED HOLE — +10/-10
0836 - DROVE SAMPLE 55-56.5' / MOVED TO GET TO 57.5'

*"DROVE HOLE" REFERS TO DRILLING HOLE
"DROVE CASING" REFERS TO PUTTING CASING IN GROUND TO KEEP HOLE OPEN

3/18/86
DATE

Robert C. [illegible]
SIGNED

Dr Kraus
APPROVED

AR304751

QA: QUINLAN

Site WVOW

Boring No. GW-46

SHEET 5 OF 6

0840 - Began placing PVC casing into hole starting w/15' of slot 0.020" screen (5' then 10' sections) w/ bottom plug, then 45' of solid PVC casing (3-10', 1-5' then 1-10' sections)
0855 - Hole fell in to ~53.5', pulled PVC to clean out hole
0905 - Returned w/ water trailer
0910 - Washed PVC & placed back into hole, [illegible]
0920 - Poured 3 bags sand in hole / Pulled casing ~3'
0930 - Poured 1½ more bags sand / Pulled casing to ~40' / Washed casing
0945 - Removed piece casing / Poured 2½ more bags sand
1000 - Pulled casing to 35' / Washed casing / Removed piece
1007 - Measured to top of sand 34' - total 7 bags sand
1010 - Poured 3 buckets bentonite pellets
1015 - Pulled casing to 30' / Washed casing / Removed piece
1022 - Measured to top of bentonite seal - 28'
1026 - Cut off top PVC to 2.2' above ground
1028 - Mixed tub grout - 3 bags cement, 1/5 bag quik-gel, 20 gals water
1036 - Poured grout / Mixed 2nd tub grout - same mix / Poured grout
1045 - Pulled casing to 20' / Grout being pulled up w/ casing, bentonite pellets must have sealed bottom of casing but PVC not being pulled up / Washed casing & removed
1055 - Pulled casing to 15' / Washed casing / Removed piece
1102 - Pulled casing to top - pulled all of grout out of hole - measured to bottom of PVC, ~1' of bentonite or grout in bottom (54'), outside of PVC to 28' so didn't lose much of seal / Washed casing
1115 - Poured ½ tub grout left from 2nd tub mixed
1119 - Mixed tub grout - same mix / Poured grout
1137 - Mixed 2nd tub grout - same mix / Poured grout
1145 - Mixed more grout using: 1 bag cement, 1/10 bag gel, 8 gals water
1155 - Began cleaning & loading equipment, preparing to move
1225 - Went to get small bailer to try to get bentonite out of bottom of PVC / Continued cleaning
1245 - Returned w/ 3" steel bailer - worked bailer [illegible] inside of PVC 4 times - didn't bring out any bentonite

3/18/86
DATE

Robert C. Hazlett
SIGNED

D. Kreno 8 Apr 86
APPROVED

AR304752

Site WVDW
Boring No. GW-46

SHEET 6 OF 6

1230 - BAILED TOTAL OF ~8 GALS WATER OUT OF WELL & MEASURED TO BOTTOM, STILL ~54' SO SOMETHING IS DOWN THERE BUT UNSURE IF BENTONITE OR SAND
1315 - BEGAN LOWERING DRILL RIG TOWER - PREPARED TO LEAVE SITE
1315 - BULLDOZER ARRIVES & PULLS WATER TRAILER OUT OFF SITE
1340 - PULLED RIG OFF SITE - LEFT SITE

MATERIALS:

15' - PVC SCREEN, SCH 40, 4" DIA., SLOT 0.020" (10' + 5' SECTIONS)
42.8' - PVC CASING, SCH 40, 4" DIA.
1 - SCREW-IN BOTTOM PLUG (PVC)
1 - SLIP-ON TOP CAP (PVC)
7 - 100 lb. BAGS No. 4 QUARTZ SAND
3 - 50 lb. BUCKETS 3/8" BENTONITE PELLETS
GROUT = 9 - 94 lb. BAGS PORTLAND TYPE I CEMENT
3/5 - 50 lb. BAGS QUIK-GEL BENTONITE MUD
60 GALS WATER

0 GALS WATER LOST IN HOLE DURING DRILLING

AR304753

3/18/86
DATE

Robert C. [illegible]
SIGNED

D. Kraus 8 Apr 86
APPROVED

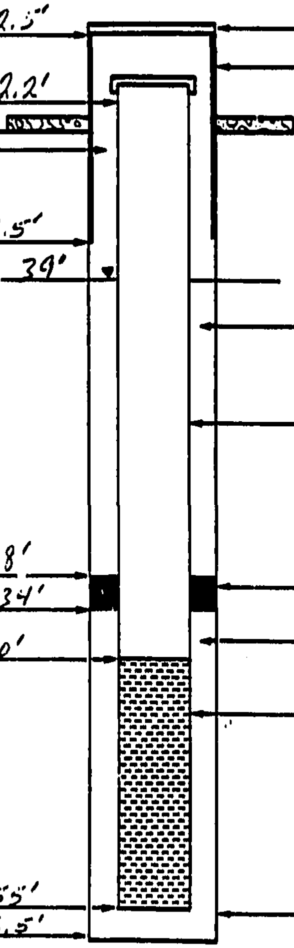
AAAP 10/4/86

MONITOR WELL CONSTRUCTION

Logged By: Robert C. Hazlett
Client: USATHAMA
Drilling Contractor: Bowser-Morner
Location: LVAAP
Driller's Name: Skaater Patterson
Job Number: 94604
Well Number: GW-46
Date/Time: Start 3/17/86 Finish 3/18/86

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing: 2.5'
Top of Well Casing: 2.2'
Top of Cement: 0'
Bottom of Protective Casing: 3.5'
First Ground Water: 39'
Top of Bentonite Seal: 28'
Top of Gravel Pack: 34'
Top of Screen: 40'
Bottom of Screen: 55'
Total Depth of Bore Hole: 56.5'

Locking Cap

Protective Pipe Type, Diameter: Steel, 6"

Cement/Gravel Pad

Type of Grout: Cement/Bentonite

Casing:
Type: PVC, Sch 40
Diameter: 4"

~~Couplings:~~ Joints
Type: Flush Threaded
Number: 6
Depths: 5', 10', 20', 30', 40', 50'

Type of Plug: Bentonite 1/4" Pellets

Gravel Pack:
Material: No. 4 Quartz Sand

Screen:
Type: PVC, Sch 40
Diameter: 4"
Length: 15' (5' + 10' sections)
Slot Size: 0.010"

AR304754

Bore Hole Diameter: 8"

NOT TO SCALE

AAAP 10408

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	500 FT NORTHWEST OF POND I RED WATER RESERVOIR AREA.
Water Level	FIRST WATER - 49'
Time	1050
Date	3/20/86

Boring No. 47 Date 3/19/86 Sheet 1 of 7

Type of Boring [illegible] Rig [illegible]

Casing used [illegible] Size 4" Drilling mud used [illegible]

Boring begun 3/19/86 Boring completed 3/21/86

Ground Elevation ______ referred to: ______ Datum

Field Party: R. HAZLETT, [illegible] JEFF AUSTIN

Depth of Casing, Ft.	Sample No.	Sample Depth from-to in Feet	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		SANDY CLAY W/~20% SAND; BROWN; MED. PLASTIC; SOFT; SLIGHTLY MOIST; ALLUVIUM.
	1	5-6.5'			1.5'	CH	5		FAT CLAY W/NO SILT OR SAND; 10YR 6/4- DK YELLOW BROWN; HIGHLY PLASTIC; LOOSE; MOIST; NAP; ALLUVIUM.
	2	10-11.5'			1.2'	SP/SC	10		POORLY GRADED FINE SAND W/LITTLE SILT ~10% AND 3 1"-3" LAYERS OF CLAYEY SAND W/~30% CLAY [illegible]; 10YR 4/4- DK YELLOW BROWN; NOT PLASTIC [illegible]; LOOSE; DRY; ALLUVIUM.
	3	15-16.5'			0.9'	SP	15		POORLY GRADED FINE SAND W/LITTLE SILT ~5%; 10YR 5/4- YELLOW BROWN; NOT PLASTIC; LOOSE; DRY; NAP; ALLUVIUM.
	4	20-21.5'			0.8'	SP	20		POORLY GRADED FINE SAND W/LITTLE SILT ~5%; 10YR 5/4- YELLOW BROWN; NOT PLASTIC; LOOSE; DRY; ALLUVIUM.

AR304755

Signed [signature] Date 3/19/86

Approved D.K. Date 4/20

AR304755

AAAP 19408

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVOW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 47 Date 3/20/86 Sheet 2 of 7

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth (From-To in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	5	25-26.5'			1.0'	SW	25		Well graded gravelly sand w/ ~20% fine gravel and <5% silt, [illegible] fine to med. sand, gravel is rounded to well rounded. 10YR 5/4 - yellowish brown; not plastic; loose, dry; [illegible] alluvium.
	6	30-31.5'			1.0'	SW	30		Poorly graded gravel. Sand w/ ~15% fine gravel and [illegible] silt, [illegible] fine to med. sand; 10YR 4/4 - dk yellowish brown; not plastic; loose; top part of sample was possibly due to water added; 1/2" brown fine grained layer of [illegible] at bottom of sample. [illegible] the lower sand is dry so [illegible] [illegible] water table; alluvium.
	7	35-36.5'			1.0'	SP	35		Poorly graded sand w/ some gravel [illegible] at top [illegible] and <5% silt 10YR 5/4 - yellowish brown; not plastic [illegible]; dry; alluvium. [illegible] at 35-36' [illegible] dk [illegible] brown [illegible] silt [illegible] sample. [illegible]
	8	40-41.5'			1.0'	SP	40		Poorly graded fine to med. sand w/ <5% silt [illegible] w/ 5" [illegible] [illegible] 10YR [illegible] - yellowish [illegible] [illegible] alluvium.

AR30[illegible]75

Signed [illegible signature] Date 3/20/86

Approved DLC Date 4/20

B-67

AR304756

AAAP 104/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USA THAMA

Project W... [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 47 Date 3/22/86 Sheet 3 of 7

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									POORLY GRADED FINE SAND W/ [illegible] SILT; 10YR 5/4 - YELLOW BROWN; NOT PLASTIC; LOOSE; [illegible]
	9	45-46.5'			1.0'	SP	45		
									POORLY GRADED FINE SAND W/ [illegible] [illegible]
	10	50-51.5'			1.0'	SP	50		
									POORLY GRADED FINE SAND W/ [illegible] NOT PLASTIC; LOOSE; [illegible]
	11	55-56.5'			1.2'	SP	55		
									POORLY GRADED FINE SAND W/ [illegible] SILT [illegible] NOT PLASTIC; LOOSE; WET; [illegible]
	12	60-61.5'			1.5'	SP	60		[illegible]

Same [illegible] [illegible]

AR301757

Signed [illegible signature] Date 3/22/86

Approved DLK Date 4/20

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 37604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 47 Date 3/20/86 Sheet 4 of 7

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from to in Feet	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						SP	64		
	(No sample taken)					CH			FAT GREY CLAY IN BAILER AT 6[illegible]' DIDN'T TAKE SAMPLE BUT [illegible] WERE HIGHLY PLASTIC AND [illegible] NO SAND OR SILT.
							BOH		
									BOTTOM OF HOLE - 65'

AR304758

Signed [signature] Date 3/20/86

Approved DLK Date 4/20

Site W W O W
Boring No. GW-47

SHEET 5 OF 7

3/19/86 — WITH [illegible]

1650 - ARRIVE AT SITE - POSITION RIG + WATER TRAILER
1700 - SET UP RIG, PREPARE TO DRILL
1725 - BEGAN DRILLING - DROVE HOLE* TO 3'
1732 - DROVE CASING** TO 5' / DROVE HOLE TO 5' / BAILED HOLE +10/-5
1739 - DROVE SAMPLE 5-6.5'
1741 - DROVE CASING TO 10' / DROVE HOLE TO 10' / BAILED HOLE +5/-5
1748 - DROVE SAMPLE 10-11.5'
1750 - DROVE CASING TO 15' / DROVE HOLE TO 15' / BAILED HOLE +10/-10
1804 - DROVE SAMPLE 15-16.5'
1806 - DROVE CASING TO 18' / DROVE HOLE TO 20' / BAILED HOLE +10/-10
1815 - DROVE SAMPLE 20-21.5'
1817 - ADDED CASING + DROVE TO 28' / DROVE HOLE TO 28' / BAILED HOLE +5/-5
1835 - SHUT DOWN RIG FOR DAY
1840 - LEFT SITE FOR DAY

3/20/86

0800 - ARRIVED AT SITE
0805 - DROVE CASING TO 25' / DROVE HOLE TO 25' / BAILED HOLE +5/-10
0815 - DROVE SAMPLE 25-26.5'
0817 - ADDED CASING / DROVE CASING TO 30'
0830 - DROVE HOLE TO 30' / BAILED HOLE +5/-15
0840 - DROVE SAMPLE 30-31.5'
0845 - WELDED TOP ON CASING WHICH WAS LOOSE
0858 - DROVE CASING TO 34' / DROVE HOLE TO 34' / BAILED HOLE +5/-10
0910 - ADDED CASING / DROVE CASING TO 35' / DROVE HOLE TO 35' / BAILED HOLE +0/-5
0922 - DROVE SAMPLE 35-36.5'
0925 - DROVE CASING TO 37' / DROVE HOLE TO 37' / BAILED HOLE +4/-10
0935 - DROVE HOLE TO 40' / DROVE CASING TO 40' / BAILED HOLE +5/-15
0947 - DROVE SAMPLE 40-41.5'
0950 - ADDED CASING / DROVE HOLE TO 42' / DROVE CASING TO 44' / BAILED +3/-10
1010 - DROVE HOLE TO 45' / DROVE CASING TO 45' / BAILED HOLE +0/-4
1020 - DROVE SAMPLE 45-46.5'
1033 - ADDED CASING / DROVE CASING TO 52'
1051 - DROVE HOLE TO 52' / BAILED HOLE +7/-10
1103 - DROVE SAMPLE 52-53.5'

* "DROVE HOLE" REFERS TO DRILLING HOLE
** "DROVE CASING" REFERS TO PUTTING CASING INTO GROUND TO HOLD OPEN HOLE

3/20/86
DATE

[illegible] AR301759
SIGNED

DK 4/20
APPROVED

Site WWJW
Boring No. GW-47 SHEET 6 OF 7

(WATER LEVEL/BAILED)

1105 - DROVE CASING TO 55' / DROVE HOLE TO 55' / BAILED HOLE +5/-15
1118 - DROVE SAMPLE 55'-56.5'
1130 - SHUT DOWN [illegible]
1130 - [illegible]
1250 - RETURNED TO SITE / CHECK WATER LEVEL - 49'
1301 - DROVE HOLE TO 58' / BAILED HOLE -4/-15
1315 - ADD CASING [illegible] / DROVE CASING TO 60'
1335 - DROVE HOLE TO 60' / BAILED HOLE +8/-20
1343 - DROVE SAMPLE 60-61.5'
1346 - DROVE CASING TO 65' / DROVE HOLE TO 65' / BAILED HOLE +4/-30
1405 - MEASURED TO BOTTOM OF HOLE - 65' (300 [illegible] WATER [illegible] SAND [illegible])
1410 - BEGAN PLACING PVC CASING INTO HOLE STARTING w/ [illegible]
[illegible] (5' THEN 10' SECTION) THEN 53' OF PVC
CASING (4-10' 1-2' + 1-10' SECTIONS) - HEAD AT 65'
1432 - POURED 5 BAGS SAND / PULLED STEEL CASING TO 55' / WASHED + REMOVED CASING
1515 - PVC CASING [illegible] / [illegible] 2 BAGS SAND
1524 - PULLED 8" CASING TO 44' / WASHED + REMOVED PIECE
1549 - POURED 1/2 BAGS SAND [illegible] SAND AT 44' - USED 7 1/2 BAGS SAND
1551 - [illegible] 1 BUCKET BENTONITE PELLETS + PULLED 8" CASING [illegible] AT A TIME
1556 - ADDED 3 1/2 BUCKETS PELLETS / PULLED CASING TO 34'
1605 - MEASURED TO TOP OF BENTONITE SEAL - 30' - USED 3 1/2 BUCKETS
1609 - WASHED + [illegible] CASING + REMOVED PIECE
1625 - MIXED TUB GROUT USING 3 BAGS CEMENT, 1/2 BAG [illegible] 20 GAL WATER
1640 - POURED GROUT (THRU TREMMIE PIPE) / [illegible] PIPE [illegible]
1650 - [illegible] [illegible] GAS
1655 - [illegible] GROUT - [illegible]
1711 - PULLED 8" CASING TO 35' / WASHED + REMOVED PIECE
1722 - MIXED 2ND TUB GROUT - SAME MIX / POURED GROUT
1735 - PULLED 8" CASING TO 27' / WASHED + REMOVED PIECE
1745 - PULLED 8" CASING TO 20' / WASHED + REMOVED PIECE
1752 - MIXED 3RD TUB GROUT - SAME MIX / POURED GROUT
1810 - WASHED [illegible] TO [illegible] CLEAR [illegible] OF DRIED GROUT
1817 - PULLED CASING TO TOP OF HOLE + WASH IT
1835 - MIXED 4TH TUB GROUT - SAME MIX / POURED GROUT

AR304760

3/20/86 — DATE
[illegible] — SIGNED
DK 4/20 — APPROVED

Site LUVON
Boring No. GW-47

SHEET 7 OF 7

1833 - MIXED 5TH TUB GROUT W/2 BAGS CEMENT, 1/2 BAG QG, 15 GALS WATER
1845 - POURED GROUT
1850 - BEGAN WASHING DRILL EQUIPMENT / CUT TOP PVC TO
2.2' ABOVE GROUND / PUT PROTECTIVE CASING OVER PVC
1900 - LEFT SITE FOR DAY
3/21/86
0745 - ARRIVED AT SITE - TO [illegible] WATER TRAILER FOR MORE
WATER FOR WASHING / BEGAN BREAKING RIG TO [illegible]
0815 - LOWERED DRILLING TOWER
0845 - RETURNED W/WATER - WASHED RIG + EQUIPMENT
0920 - LEFT SITE
3/24/86
1350 - FOUND GROUT HAD SOMEHOW GOTTEN INTO SCREEN IN
BOTTOM OF HOLE - HAD TO ABANDON HOLE + GROUT IT UP /
MIXED TUB GROUT USING 3 BAGS CEMENT, 1/2 BAGS QG, 20 GALS WATER
1410 - POURED GROUT IN PVC UP TO GROUND LEVEL

MATERIALS:
15' - 4" PVC SCREEN, SCH 40, SLOT 0.0200" (5' + 10' SECTION)
52.2' - 4" PVC CASING, SCH 40 (5-10' + 1-5' SECTIONS)
1 - SCREW-IN PVC BOTTOM PLUG
1 - SLIP-ON PVC TOP CAP
7 1/2 - 100 lb. BAGS NO. 4 QUARTZ SAND
3 1/2 - 50 lb. BUCKETS BENTONITE PELLETS, 3/8" DIA.
GROUT: 17 - 94 lb. BAGS PORTLAND TYPE I CEMENT
1 1/2 - 50 lb BAGS QUIK-GEL BENTONITE MUD
115 GALS. WATER

3/21/86 DATE

[illegible] SIGNED

APPROVED

AR304761

AAAP 10/4/85

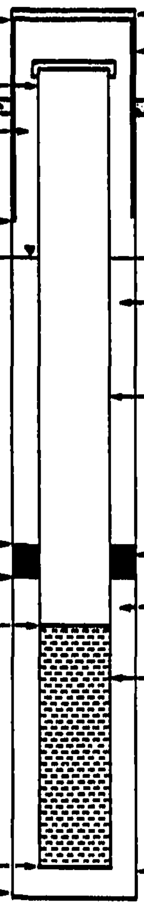
MONITOR WELL CONSTRUCTION

Logged By: Robert Hazlett
Drilling Contractor: Bowser-Morner
Driller's Name: Skaatag Patterson
Well Number: GW-47

Client: USATHAMA
Location: W Kow
Job Number: 84604
Date/Time: Start 3/19 Finish 3/21/86

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing 2.5'

Top of Well Casing 2.2'

Top of Cement 0'

Bottom of Protective Casing 3.5'

First Ground Water 49'

Top of Bentonite Seal 39'

Top of Gravel Pack 44'

Top of Screen 50'

Bottom of Screen 65'

Total Depth of Bore Hole 65'

Locking Cap

Protective Pipe
Type, Diameter 6" Steel

Cement/Gravel Pad

Type of Grout Cement/Bentonite 20:1

Casing:
Type PVC Sch 40
Diameter 4"

~~Couplings:~~ Joints: Type Flush Threaded
Number 7
Depths 5', 10', 20', 30', 40', 50', 60'

Type of Plug Bentonite Pellets 3/8"

Gravel Pack:
Material No. 4 Quartz Sand

Screen:
Type PVC Sch 40
Diameter 4"
Length 15' (5' + 10' sections)
Slot Size 0.0100"

Bore Hole Diameter 8"

AR304762

NOT TO SCALE

Note. 3/24/86 ~~Hole~~ Well abandoned and grouted to surface
DLK 4/20/86

AAAF 10468

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring: East of [illegible] Bad Water Reservoir Area

Water Level	[illegible] ~5.0'
Time	1330
Date	4/2/86

Boring No. 47 II Date 4/2/86 Sheet 1 of 7

Type of Boring [illegible] Rig [illegible]

Casing used PVC Size 4" Drilling mud used [illegible]

Boring begun 4/2/86 Boring completed 4/2/86

Ground Elevation ____ referred to ____ Datum

Field Party: [illegible]

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sample (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		Silty clay w/~20% silt; brown-tan; [illegible] plastic; soft; slightly moist; alluvium.
									Silty clay w/~15% silt - top 1.2'; poorly graded sand w/~[illegible]% silt bottom 0.3'; 10YR 5/4 - yellow brown; clay - highly plastic; sand - not plastic; clay - soft, sand - loose; slightly moist; alluvium.
	1	5-6.5'			1.5'	CL	5		
						SP			
									Poorly graded fine sand w/~15% silt; 10YR 5/4 - yellow brown; not plastic; loose; v. slightly moist; [illegible]; alluvium.
	2	10-11.5'			1.2'	SM	10		
									Well graded fine sand w/~5% silt; 10YR 5/4 - yellow brown; not plastic; loose; v. slightly moist; [illegible]; alluvium.
	3	15-16.5'			1.3'	SP	15		
									Poorly graded fine sand w/~[illegible]% silt; 10YR 5/4 - yellow brown; not plastic; loose; v. slightly moist; [illegible]; alluvium.
	4	20-21.5'			1.2'	SP	20		

AR304763

Signed [signature] Date 4/2/86

Approved DLK Date 4/20

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604
Client USATHAMA
Project WVOW

Boring No. 47 II Date 4/2/86 Sheet 2 of 2
Type of Boring ______ Rig ______
Casing used ______ Size ______ Drilling mud used ______
Boring begun ______ Boring completed ______
Ground Elevation ______ referred to ______ Datum
Field Party: ______

Location of Boring:	
Water Level	
Time	
Date	

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistancy, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	5	25-26.5'			1.5'	SP	25		Poorly graded fine sand w/~5% silt and ~5% well rounded fine gravel, and well rounded fine coarse gravel found; 10YR 5/4 - yellow brown; non plastic; loose; v. slightly moist; [illegible]; alluvium
	6	30-31.5'			1.5'	SP	30		Poorly graded fine sand w/~5% silt and ~5% well rounded fine gravel; 10YR 3/2 - v. dk brown, top 1.3'; 10YR 5/4 - yellow brown bottom 0.2'; non plastic; loose; dry; alluvium; black layer ~½" separates color change in sample.
	7	35-36.5'			1.5'	SP	35		Poorly graded fine sand w/~5% silt and ~5% well rounded fine gravel; 10YR 5/4 - yellow brown; non plastic; loose; v. slightly moist; 1/8" clay layer at ~36'; alluvium
	8	40-41.5'			1.4'	SP	40		Poorly graded fine sand w/~5% silt w/~1" silty clay layer at ~41' - has ~50% silt, then poorly graded sand w/~10% silt below silty clay; 10YR 5/4 - yellow brown; non plastic; loose, very soft; v. slightly moist; alluvium
						SP-SM			

Signed Robert C. Hazlett Date 3/2/86

Approved DLK Date 4/10

AR304764

AAAP 10/486

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project UVPOW

Location of Boring:

Water Level

Time

Date

Boring No. 47 Date 9/2/86 Sheet 3 of 7

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									POORLY GRADED FINE SAND W/ <5% SILT; 10YR 5/4 - YELLOW BROWN; NOT PLASTIC; LOOSE; V. SLIGHTLY MOIST; NAR; ALLUVIUM.
	9	45-46.5'			1.5'	SP	45		
									POORLY GRADED FINE SAND W/ <5% SILT; 10YR 5/4 - YELLOW BROWN; NOT PLASTIC; LOOSE; WET; BOTTOM 3" OF SAMPLE HAS SILTY BLACK LAYERS INTERGRADED W/ SAND; ALLUVIUM.
	10	50-51.5'			1.5'	SP	50		
									POORLY GRADED FINE SAND W/ <5% SILT; 10YR 5/4 - YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAR; ALLUVIUM; 5 BLACK, SILTY STREAKS OR LENSES ~1/8" WIDE, OCCUR IN BOTTOM OF SAMPLE.
	11	55-56.5'			1.5'	SP	55		
									POORLY GRADED FINE SAND W/ <5% SILT; 10YR 5/4 - YELLOW BROWN; NOT PLASTIC; LOOSE; WET; NAR; ALLUVIUM; 0.5" LAYER RED-BROWN SAND AT 60.1'
	12	60-61.5'			1.5'	SP	60		BOTTOM 5"
						OH			FAT CLAY W/ NO SAND OR SILT; 5Y 4/1 - DK. GRAY; HIGHLY PLASTIC; SOFT; MOIST; NAR; ALLUVIUM;
						SP			~" POORLY GRADED SAND INT SAND BELOW THAT BROWN CLAY LAYER.

FIRST ENCOUN. AT 48' SAND WET

Signed Robert C. [illegible] Date 9/2/86

Approved [illegible] Date 4/20

AR304765

AAAP 10468

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 47 II Date 4/2/86 Sheet 4 of 2

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth (in Feet)	Blows/Foot on Sampler	ID of Sampler	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						SP			Fat clay w/ [illegible] silt on [illegible] - [illegible]
	(No sample taken)					CH	65'		[illegible]; dk. gray; [illegible] plastic; stiff; [illegible].
							BOH		
									Bottom of hole - 65'

AR304766

Signed [signature] Date 4/11/86

Approved DK Date 4/20

Site WVOW
Boring No. GW-47 II

SHEET 5 OF 7

WATER USED (GALS)

4/2/86

1400 - ARRIVED AT SITE - POSITIONED RIG / RAISED DRILL TOWER
1420 - LEVELED RIG - PREPARED TO DRILL
1430 - DROVE TEMPORARY 8" CASING TO START HOLE
1435 - DRILLED TO 5' / BAILED HOLE
1441 - DROVE SAMPLE 5-6.5' +5/-5
1443 - PULLED TEMPORARY 8" CASING / DROVE 8" CASING W/DRIVE SHOE TO 12'
1505 - DRILLED TO 10' / BAILED HOLE +8/-10
1508 - DROVE SAMPLE 10-11.5'
1511 - DRILLED TO 15' / BAILED HOLE
1514 - DROVE SAMPLE 15-16.5'
1520 - ADDED CASING - WELDED JOINT / DROVE CASING TO 24'
1546 - DRILLED TO 20' / BAILED HOLE +5/-10
1546 - DROVE SAMPLE 20-21.5'
1548 - DRILLED TO 25' / BAILED HOLE +7/-10
1555 - DROVE SAMPLE 25-26.5'
1558 - ADDED CASING - WELDED JOINT / DROVE CASING TO 35'
1626 - DRILLED TO 30' / BAILED HOLE +5/-5
1635 - DROVE SAMPLE 30-31.5'
1638 - DRILLED TO 35' / BAILED HOLE +5/-5
1645 - DROVE SAMPLE 35-36.5'
1648 - ADDED CASING - WELDED JOINT / DROVE CASING TO 43'
1715 - DRILLED TO 40' / BAILED HOLE +5/-5
1731 - DROVE SAMPLE 40-41.5'
1735 - DRILLED TO 45' / BAILED HOLE +5/-5
1747 - DROVE SAMPLE 45-46.5'
1750 - ADDED CASING - WELDED JOINT / DROVE CASING TO
1820 - DRILLED TO 50' / BAILED HOLE +5/-5
1827 - DROVE SAMPLE 50-51.5'
1835 - SHUT DOWN RIG FOR DAY
1840 - LEFT SITE FOR DAY

4/3/86

0755 - ARRIVED AT SITE - PREPARED TO DRILL
0804 - DROVE 8" CASING TO 53'

AR304767

4/3/86 DATE — Herbert C. Harker SIGNED

DK 4/20 APPROVED

Site WVOW
Boring No. GW-47 II

SHEET 6 OF 7

	Water Used (Gals)
0806 - Drilled to 53' / Bailed hole	+5/-15
0810 - Added casing - welded joint / Drove casing to 60'	
0828 - Drilled to 55' / Bailed hole	+5/-10
0832 - Drove sample 55-56.5'	
0835 - Drilled to 60' / Bailed hole	
0845 - Drove sample 60-61.5'	+5/-20
0848 - Drove casing to 62'	
0854 - Drilled to 65' / Bailed hole	+10/-20
0909 - Drove casing to 65' / Bailed hole	+15/-40
0919 - Began placing PVC casing into hole starting w/ 15' slot 0.020" screen (5' thru 10' sections) w/ bottom plug then 55' PVC casing (5-10' + 1-5' sections) bottom of screen at 64'	
0935 - Poured 5 bags sand	
0937 - Pulled 8" casing to 53' / Washed, cut, + removed piece	
0948 - Poured 2½ bags sand	
0953 - Pulled 8" casing to 43' / Washed, cut, + removed piece	
1000 - Measured to top sand - 44' - used 7½ bags sand	
1003 - Poured 2 buckets bentonite pellets / Pulled 8" casing to 38' / Washed, cut, + removed piece	
1020 - Measured to top of seal - 39' - used 2 buckets pellets / Poured 10 gals water on pellets in hole	
1025 - Mixed 1st tub grout using 3 bags cement, ¼ bag bentonite, 20 gals water	
1035 - Poured grout	
1038 - Mixed 2nd tub grout - same mix / Poured grout	
1053 - Pulled 8" casing to 24' / Washed, cut, + removed piece	
1111 - Mixed 3rd tub grout - same mix / Poured grout	
1120 - Pulled 8" casing to 15' / Washed, cut, + removed piece	
1130 - Pulled 8" casing to top of hole / Washed + removed it	
1135 - Mixed 4th tub grout - using 2 bags cement, ½ bag bent., 15 gals water / Poured grout	
1145 - Cut PVC casing to 2.2' above ground / Washed 8" casing and equipment + rig	
1200 - Broke for lunch	

AR304768

4/3/86 Robert C. Harlan
DATE SIGNED

DK 4/20
APPROVED

Site WVOW

Boring No. GW-47 II

SHEET 7 OF 7

1230 - BEGAN PUTTING 8" CASING ON TRAILER / PUTTING UP EQUIPMENT / PREPARING TO MOVE RIG

1305 - LOWERED DRILL TOWER

1330 - MOVED RIG OFF SITE

1340 - PLACED PROTECTIVE STEEL CASING OVER PVC CASING W/CAP

1400 - LEFT SITE

MATERIALS:

15' - 4" PVC SCREEN SCH 40 SLOT 0.020" (5' + 10' SECTIONS)

51.8' - 4" PVC CASING SCH 40 (5-10' + 1-5' SECTIONS)

1 - SCREW-IN BOTTOM PLUG

1 - SLIP-ON TOP CAP

7½ - 100 lb. BAGS No. 4 QUARTZ SAND

2 - 50 lb. BUCKETS BENTONITE PELLETS 3/8"

GROUT: 11 - 94 lb. BAGS PORTLAND TYPE I CEMENT

1 - 50 lb. BAG QUIK GEL BENTONITE MUD

75 GALS WATER

AR304769

4/3/86 — DATE

Robert P. Hackett — SIGNED

DK 4/20 — APPROVED

AAAP 10/4/86

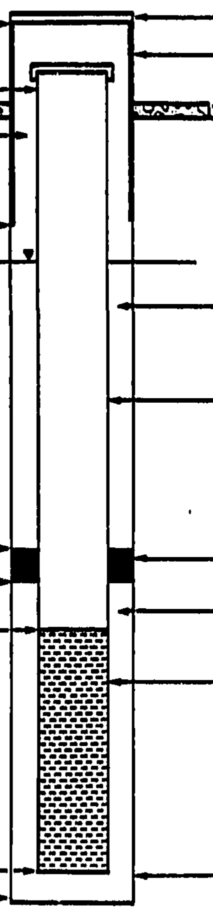
MONITOR WELL CONSTRUCTION

Logged By: Robert Hazlett
Drilling Contractor: Bowser-Morner
Driller's Name: Skeetar Patterson
Well Number: GW-47 II

Client: USATHAMA
Location: WVOW
Job Number: 84604
Date/Time: Start 4/2/86 Finish 4/2/86

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing 2.5'
Top of Well Casing 2.2'
Top of Cement 0'
Bottom of Protective Casing 3.5'
Ground Water 50'
Top of Bentonite Seal 39'
Top of Gravel Pack 44'
Top of Screen 49'
Bottom of Screen 64'
Total Depth of Bore Hole 65'

Locking Cap
Protective Pipe Type, Diameter 6" Steel
Cement/Gravel Pad
Type of Grout Cement/Bentonite 1:2
Casing:
Type PVC Sch 40
Diameter 4"
~~Couplings~~ Joints: Type Flush Threaded
Number 7
Depths 1',9',19',29',39',49',59'
Type of Plug Bentonite Pellets 3/8"
Gravel Pack: Material No. 4 Quartz Sand
Screen:
Type PVC Sch 40
Diameter 4"
Length 15' (5'+10' sections)
Slot Size 0.020"
Bore Hole Diameter

AR304770

NOT TO SCALE

Approved: 2K 4/10

AAAP 10/488

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 94604

Client USATHAMA

Project [illegible]

Location of Boring: WEST OF POND 13 NORTH OF TNT AREA	
Water Level	
Time	
Date	

Boring No. OW 32 Date 3/30/86 Sheet 1 of 2

Type of Boring [illegible] Rig HAND AUGER

Casing used [illegible] Size 1" Drilling mud used —

Boring begun 3/30/86 Boring completed 3/30/86

Ground Elevation ______ referred to ______ Datum

Field Party: JOE WHITTINGTON; ROBERT [illegible]

Depth of Casing Ft.	Sample No.	Sample Depth From to (In Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		SANDY CLAY W/~10% SAND; MOTTLED GRAY-BROWN; MEDIUM PLASTIC; V. SLIGHTLY MOIST; DENSE; ALLUVIUM.
						CL	5		SANDY CLAY W/~5% SAND; MOTTLED GRAY-BROWN; HIGHLY PLASTIC; V. SLIGHTLY MOIST; DENSE; ALLUVIUM.
						SP	10		FINE SAND WELL GRADED W/~5% CLAY; GRAY; NOT PLASTIC; LOOSE; WET; ALLUVIUM.
									BOTTOM OF HOLE - 14'
							BOH		

AR304771

Signed ROBERT C. [illegible] Date 3/30/86

B-82 Approved DLK Date 4/20

Site WVOW
Boring No. OW 32

SHEET 2 OF 2

3/30/86

1300 - ARRIVED AT SITE

1320 - USING HAND AUGER, AUGERED TO 5'

1340 - AUGERED TO 10' - HIT WET SAND AT 9.5'

1405 - USING SLEDGE HAMMER, DROVE DRIVE POINT W/SLOT SCREEN AND 2.5' SECTIONS 1" BLACK IRON CASING TO 14'

1510 - MIXED BUCKET GROUT + TOPPED HOLE AROUND CASING W/GROUT

AR304772

3/30/86
DATE

Robert C. Harcourt
SIGNED

DLK 4/20
APPROVED

AAAP 10/4/85

~~MONITOR~~ OBSERVATION WELL CONSTRUCTION

Logged By: Robert Hallett Client: USATHAMA
Drilling Contractor: ______ Location: WVAW
Driller's Name: Installed by USC ... Job Number: 84604
Well Number: OW 323 Date/Time: Start 3:30 Finish 3/20/86
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level

Top of Protective Casing

Top of Well Casing 1.2'

Top of Cement 0'

~~Bottom of Protective Casing~~

~~Ground Water~~

~~Top of Bentonite Seal~~

~~Top of Gravel Pack~~

Top of Screen

Bottom of Screen 14'

Total Depth of Bore Hole 14'

Locking Cap } Slip cap, PVC 1 1/4" Diam. Bolt thru...

Protective Pipe }

~~Type, Diameter~~ Hole filled ... tapped

Cement/~~Gravel~~ Pad

Type of Grout Cement/Bentonite 1:2

Casing:
Type Black Iron
Diameter 1"

Couplings:
Type ~~Flush thread~~ External
Number 2
Depths 4', 9'

Type of Plug None

Gravel Pack:
Material Natural Formation Sand

Screen:
Type Johnson Redhead Drive Point
Diameter ~~...~~ 1 1/4" I.D.
Length 2 ft
Slot Size .010 Stainless Steel, wire wound.

Hand Auger - 3" diameter hole ~~Bore Hole Diameter~~

AR304779

NOT TO SCALE

AAAP 10/4/80

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	Northeast side [illegible] 14, North of TNT Area
Water Level	First water - 25'
Time	[illegible]
Date	3/22/86

Boring No. 480 Date 3/21/86 Sheet 1 of 11

Type of Boring [illegible] Rig [illegible]

Casing used PVC Size 4" Drilling mud used [illegible]

Boring begun 3/21/86 Boring completed 3/22/86

Ground Elevation ______ referred to ______ Datum

Field Party: R. Hazlett; [illegible]

Depth of Casing Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	0	—			--	CL	0		Sandy clay w/ trace of fine gravel, tan-brown in color, med. plastic, dense; moist; alluvium
	1	5-6.5'			0.7'	CH	5		Fat clay w/ no sand or silt: 10YR 5/4 yellow-brown and 5Y 5/1 gray mottled; highly plastic; med. dense; dry; mottled [illegible] present; alluvium
	2	10-11.5'			1.4'	CH	10		Fat clay w/ no sand or silt: 10YR 5/4 yellow brown w/ some dark brown mottles; highly plastic; dense; [illegible]; alluvium; dry.
	3	15-16.5'			1.3'	CH	15		Fat clay w/ no sand or silt. One piece of rounded gravel at ~16'; 10YR 5/4 yellow brown; highly plastic; dense; dry; [illegible]; alluvium
	4	20-21.5'			1.5'	CH	20		Fat clay w/ no sand or silt: 10YR 5/4 yellow brown w/ some gray & dk. brown mottling; highly plastic; dense; dry; [illegible]; alluvium

AR304774

Signed Robert C. Hazlett Date 3/21/86

Approved [illegible] Date 4/20

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVRW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 43D Date 3/21/86 Sheet 2 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth From-to (In Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									FAT CLAY W/NO SAND BUT BOTTOM 3.5" OF SAMPLE APPEARS TO CONTAIN MICACEOUS SILT; 10YR 5/4 - YELLOWISH BROWN W/GRAY MOTTLING; HIGHLY PLASTIC; DENSE; DRY; NAR; ALLUVIUM.
	5	25-26.5'			1.5'	CH	25		
									CLAYEY SAND W/~20% CLAY AND ~5% FINE GRAVEL WELL-ROUNDED IN FINE SAND; 10YR 4/1 - DK GRAY; NOT PLASTIC; LOOSE; WET; NAR; ALLUVIUM
							30		FAT CLAY W/NO SAND IN BOTTOM 2" OF SAMPLE; 10YR 5/1 - GRAY; HIGHLY PLASTIC; MED. DENSE; V. SLIGHTLY MOIST; NAR; ALLUVIUM.
	6	30-31.5'			1.5'	SC CH			
									MICACEOUS FAT CLAY W/NO SAND OR SILT; 5Y 4/1 - DK GRAY; HIGHLY PLASTIC; MED. DENSE; SLIGHTLY MOIST; NAR; ALLUVIUM.
	7	35-36.5'			1.5'	CH	35		
									MICACEOUS FAT CLAY W/NO SAND OR SILT; 5Y 4/1 DK GRAY; HIGHLY PLASTIC; MED. DENSE; SLIGHTLY MOIST; NAR; ALLUVIUM.
	8	40-41.5'			1.5'	CH	40		AR304775

Signed Robert C. Hoover Date 3/21/86

Approved DK Date 4/20

AAAP 10/4/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84104

Client USATHAMA

Project WRCCU

Boring No. 49D Date 3/21/8[illegible] Sheet 3 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Location of Boring:	
Water Level	
Time	
Date	

Depth of Casing, Ft.	Sample No.	Sample Depth Inter. (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
	9	45-46.5'			1.5'	CH	45		FAT MICACEOUS CLAY w/ [illegible] SAND OR SILT; 5Y 4/1 DK. GRAY; HIGHLY PLASTIC; MED. DENSE; V. SLIGHTLY MOIST; NAB; ALLUVIUM.
	10	50-51.5'			1.5'	CH	50		FAT MICACEOUS CLAY w/ [illegible] SAND OR SILT; 5Y 4/1 - DK GRAY; HIGHLY PLASTIC; MED. DENSE; V. SLIGHTLY MOIST; NAB; ALLUVIUM.
	11	55-56.5'			1.5'	CH	55		FAT MICACEOUS CLAY w/ [illegible] SAND OR SILT; 5Y 4/1 - DK GRAY; HIGHLY PLASTIC; MED. DENSE; V. SLIGHTLY MOIST; NAB; ALLUVIUM.
	12	60-61.5'			1.5'	CL	60		SILTY, MICACEOUS CLAY w/ 1/2" LAYER OF SANDY CLAY AT ~61.3'; [illegible] OF WOOD STICKS ~[illegible] AT ~61'; 5Y 3/1 V. DK. GRAY; HIGHLY PLASTIC; [illegible]; SLIGHTLY MOIST; NAB; ALLUVIUM. SANDY CLAY LAYER IS WET; BELOW SANDY CLAY, CLAY IS [illegible], EASIER TO DRILL.

AR30477

Signed [illegible] Date 3/21/8[illegible]

Approved DLK Date 4/20

AR304776

AAAP 10/4/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVNW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 49D Date 3/21/86 Sheet 4 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CH			
									Sandy clay w/~40% fine sand and ~5% black, well rounded fine gravel and ~10% silt; 5Y 4/1-4 dk. gray; low to not plastic; loose; wet; some clay layers 1" interbedded; alluvium.
	13	65-66.5'			1.5'	SC	65		
						CH			At 66' fat clay, same as previous 5Y or 5G ... 5Y 4/1 - dk gray; highly plastic; med dense; slightly moist; NAB; alluvium.
									Note: when sandy clay drilled thru water filled casing to ~20' from surface.
							70		Fat (?) clay w/ sand or silt; 5Y 4/1 - dk gray; highly plastic; med dense; v. slightly moist; NAB; alluvium.
	14	70-71.5'			1.5'	CH			
									Poorly graded fine sand w/~15% silt and some clay lenses or balls, one rock fragment ~1" dia. in sample; silt-stone or claystone; 5Y 4/1 - dk gray; not plastic except clay lenses - highly plastic; loose; wet; NAB; alluvium
	15	75-76.5'			0.8'	SM	75		
									Poorly graded fine sand w/~5% silt; 5Y 5/2 - olive gray; not plastic; loose; moist; NAB; alluvium.
	16	80-81.5'			1.5'	SP	80		

First water ~75' sample

AR304777

Signed Robert C. Hallett Date 3/23/86

Approved DK Date 4/20

AAAF 10/4/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project [illegible]

Location of Boring:	
Water Level	
Time	
Date	

Boring No. [illegible] Date 3/22/86 Sheet 5 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									Poorly graded fine sand w/~5% silt; 5Y 5/2 olive gray; not plastic; loose; moist; [illegible] alluvium
	17	85-86.5'			1.5'	SP	85		
						GW-GC			Well graded sandy clayey gravel w/~60% well rounded gravel, ~[illegible] fine sand and ~[illegible] clay; 5Y [illegible] dk olive gray; [illegible] not plastic; med dense; moist; [illegible]; glacial outwash.
									Well graded sandy-clayey gravel w/~60% well rounded gravel, ~30% fine to med sand and ~10% clay or silt; 10YR 4/3 brown; not plastic; med dense; wet; [illegible]; glacial outwash. Note: [illegible] well rounded gravel & [illegible] and some sandstone fragments (~70%)
	18	[illegible]-91.5'			1.5'	GW-GC	90		
									Well graded gravelly-clayey sand w/~35% well rounded gravel & rock fragments (sandstone), ~5% clay or silt [illegible] fine to med sand; 2.5Y 5/2 grayish brown; not plastic; med dense; wet; [illegible]; alluvium. ~70% Note: [illegible] well rounded gravel, [illegible] fragments
	19	95-96.5'			1.5'	SW	95		
									Poorly graded fine sand w/~5% silt and ~5% gravel which grades into sand w/more silt or clay (~[illegible]) at bottom of sample; 2.5Y 5/2 gray brown upper sample, bottom 0.5' is 2.5Y 4/4 olive brown; not plastic; med dense; wet; [illegible]; alluvium
	20	100-101.5'			1.5'	SP	100		
									Poorly graded sand w/~[illegible] silt or clay and ~10-15% fine gravel, well rounded & [illegible] fine to med sand; 2.5Y 5/2 gray brown; not plastic; med dense; wet; [illegible]; alluvium
							105		
	21	105-106.5'			1.5'	SP			

Signed [illegible] Date 3/22/86

Approved [illegible] Date 4/[illegible]

AR304778

AAAP 10/485

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project WVAW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 48D Date 3/22/86 Sheet 6 of 11

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									BOTTOM 3" OF SAMPLE IS CLAYEY-SANDY GRAVEL W/~30% CLAY, ~20% FINE SAND AND ~50% WELL ROUNDED GRAVEL; GREENISH GRAY-BLUE COLOR; MOD. PLASTIC; MOD DENSE; WET; NAR; ALLUVIUM. VERY BOTTOM OF SAMPLE HAS SOME RED-BROWN COLORED CLAY.
						SP	105		
						GC			
							106		
							107		WELL GRADED CLAYEY-SANDY GRAVEL W/~30% CLAY, ~15% SAND AND ~55% WELL ROUNDED GRAVEL; GREENISH GRAY-BLUE W/SOME 7.5R 3/2 - DUSKY RED STAINED CLAY AT BOTTOM OF SAMPLE; MOD PLASTIC; DENSE; WET; NAR; ALLUVIUM.
							108		
	21A	108.5-109.5'			1.0'	GW-GC			
							109		MICACEOUS CLAY W/NO SAND OR SILT; GREENISH BLUE-GRAY COLOR; HIGHLY PLASTIC; DENSE; DRY; NAR; ALLUVIUM
	22	109-110'			0.5'	CH-Shale	110		
							BOH		RED MICACEOUS SHALE; 7.5R 3/2 - DUSKY RED; DENSE; DRY.
									BOTTOM OF HOLE - 110' (BOH)

AR304779

Signed [illegible signature] Date 3/22/86

\# CHANGED BELOW AS INDICATED

Approve: DLK Date 4/20

Site WVOW
Boring No. GW-49D

SHEET 7 OF 11

Water Used (Gal)

3/21/86

0950 - ARRIVED AT SITE - POSITIONED RIG + CLEARED SITE /
SET-UP RIG TO START DRILLING
1100 - DROVE CASING (8")* TO START HOLE
1112 - DROVE HOLE* TO 5' / BAILED HOLE +20/-20
1121 - DROVE SAMPLE 5-6.5'
1125 - DROVE HOLE TO 10' / BAILED HOLE +20/-20
1150 - DROVE SAMPLE 10-11.5'
1155 - DROVE HOLE TO 15' / BAILED HOLE +10/-20
1210 - STOPPED TO FIX WATER HOSE CONNECTIONS
1231 - DROVE SAMPLE 15-16.5'
1239 - DROVE HOLE TO 20' / BAILED HOLE +10/-10
1250 - DROVE SAMPLE 20-21.5'
1255 - DROVE HOLE TO 25' / BAILED HOLE +10/-10
1312 - DROVE SAMPLE 25-26.5'
1315 - PULLED TEMPORARY 8" CASING OUT OF HOLE / DROVE
8" CASING TO 20'
1335 - BROKE FOR LUNCH
1405 - CLEANED OUT HOLE TO 25' - DRIVING CASING FILLED IT IN +10/-10
1424 - DROVE HOLE TO 30' / BAILED HOLE +10/-25
1443 - DROVE SAMPLE 30-31.5'
1445 - ADDED CASING / DROVE CASING TO 27'
1455 - ADDED CASING / DROVE CASING TO 30'
1505 - DROVE HOLE TO 35' / BAILED HOLE +15/-25
1521 - DROVE SAMPLE 35-36.5'
1523 - DROVE HOLE TO 40' / BAILED HOLE +10/-10
1530 - DROVE SAMPLE 40-41.5'
1533 - ADDED CASING / DROVE CASING TO 40'
1538 - DROVE HOLE TO 45' / BAILED HOLE +10/-10
1550 - ADDED CASING / DROVE CASING TO 45'
1555 - CLEANED HOLE TO 45' -20
1600 - DROVE SAMPLE 45-46.5'
1604 - DROVE HOLE TO 50' / BAILED HOLE +10/-10
1613 - DROVE SAMPLE 50-51.5'
1616 - DROVE HOLE TO 55' / BAILED HOLE

AR304780

3/21/86
DATE

[illegible]
SIGNED

DVL 4/2
APPROVED

* "DROVE HOLE" REFERS TO DRILLING HOLE
* "DROVE CASING" REFERS TO PUTTING 8" CASING INTO GROUND TO HOLD HOLE OPEN

Site WVJW
Boring No. GW-48D

SHEET 8 OF 11

WATER USED (GAL)

1628 - DROVE SAMPLE 55-56.5'
1631 - ADDED CASING / DROVE CASING TO 59'
1641 - DROVE HOLE TO 60' / BAILED HOLE +10/-10
1701 - DROVE SAMPLE 60-61.5'
1705 - ADDED CASING - WELDED JOINT / DROVE CASING TO 65'
1725 - DROVE HOLE TO 65' / BAILED HOLE +0/-30
1748 - DROVE SAMPLE 65-66.5'
1751 - DROVE HOLE TO 70' / BAILED HOLE +5/-20
1807 - DROVE SAMPLE 70-71.5'
1809 - DROVE HOLE TO 73' / BAILED HOLE +5/-15
1830 - ADDED CASING - WELDED JOINT / DROVE CASING TO 73'
1845 - SHUT DOWN RIG
1850 - LEFT SITE FOR DAY
3/22/81
0810 - ARRIVED AT SITE - REPOSITIONED WATER TANK ON TRAILER AND WELDED IN PLACE
0835 - LEFT TO GET WATER / DRILLED - CLEANED HOLE TO 75' / BAILED +0/-50
0902 - DROVE SAMPLE 75-76.5'
0905 - ADDED 5' CASING - WELDED JOINT / DROVE CASING TO 82'
0930 - BAILED TO 80' / BAILED HOLE +0/-30
0945 - DROVE SAMPLE 80-81.5'
0946 - DROVE CASING TO 86' / BAILED HOLE TO 85' +0/-30
1000 - DROVE SAMPLE 85-86.5'
1004 - DRILLED TO 86' / BAILED HOLE +25/-15
1020 - ADDED CASING - WELDED JOINT / DROVE CASING TO 93'
1045 - DRILLED TO 90' / BAILED HOLE
1052 - BAILER BITTEN DOWN, HAD TO ADD NEW RUBBER SHOE TO BOTTOM
1120 - [illegible] / [illegible] DRILLING TO 90' +0/-20
1135 - DROVE SAMPLE 90-91.5'
1141 - DRILLED TO 93' / BAILED / DROVE CASING TO 93' +0/-15
1155 - DRILLED TO 95' / BAILED HOLE / DROVE CASING TO 95' / BAILED +8/-60
1220 - DROVE SAMPLE 95-96.5'
1225 - DRILLED TO 97' / BAILED HOLE / DROVE CASING TO 97' +0/-25

3/22/81
DATE

SIGNED

4/20
APPROVED

AR304781

Site WIDOW

Boring No. GW-48D

SHEET 9 OF 11

	WATER USED (GAL)
1235 - BROKE FOR LUNCH	
1300 - BAILED HOLE / DROVE CASING TO 99'	-15
1310 - DRILLED TO 99' / BAILED HOLE	+15/-20
1320 - ADDED CASING - WELDED JOINT / DROVE CASING TO 100'	
1332 - DRILLED TO 100' / BAILED HOLE	+5/-20
1338 - DROVE SAMPLE 100-101.5'	
1342 - DROVE CASING TO 105' / DRILLED TO 105' / BAILED HOLE	+10/-30
1357 - DROVE SAMPLE 105-106.5'	
1400 - ADDED CASING - WELDED JOINT / DROVE CASING TO 108'	
1420 - DRILLED TO 108' / BAILED HOLE	+0/-20
1440 - DROVE SAMPLE 108-109.5' - NO SAMPLE RECOVERED - NO PENETRATION	
1445 - DROVE CASING TO 108'	
1455 - DRILLED TO 108.5' / BAILED HOLE	+0/-20
1520 - DROVE SAMPLE 108.5-109.5' - TRYING TO DETERMINE IF HIT BEDROCK	
1525 - DROVE TO 109' / BAILED HOLE	+0/-20
1540 - DROVE SAMPLE 109-110' - HIT BEDROCK - RED SHALE	
1547 - CUT OFF TOP OF 8" CASING TO PREPARE TO PLACE PVC	
1600 - TOO LATE TO START SETTING WELL W/OUT COMPLETING SO QUIT FOR DAY / MEASURED DEPTH OF HOLE - 109'	
1610 - LEFT SITE FOR DAY AFTER CAPPING 8' CASING W/DRILL BIT	
3/23/86	
0715 - ARRIVED AT SITE - PREPARED TO SET WELL	
0730 - BEGAN PLACING PVC CASING IN HOLE STARTING W/20' SCREEN, SLOT SIZE .020" (2-10' SECTIONS) W/BOTTOM PLUG, THEN 90' PVC CASING (9-10' SECTIONS) - BOTTOM OF SCREEN AT 107'	
0750 - POURED 6 BAGS SAND + WATER POURED OUT TOP OF PVC ~ 50 GAL BLOWN OUT OF HOLE, LAST WENT BACK INTO HOLE	
0758 - PULLED 8" CASING TO 97' + CUT OFF TOP PIECE	
0923 - POURED 2 BAGS SAND / PULLED CASING (8") TO 84' / CUT + REMOVED TOP PIECE	
0945 - POURED 1 BAG SAND / PULLED 8" CASING TO 81' / MEASURED TO TOP OF SAND PACK - 81', USED 9 BAGS SAND	
0955 - WELDED CASING + CUT + REMOVED TOP PIECE	
0920 - POURED 2 BUCKETS BENTONITE PELLETS (1/2") + PULLED CASING TO 75'	
- TOP OF BENTONITE - 76'	

3/23/86
DATE

Robert C. Hallett
SIGNED

Dull 4/20
APPROVED

AR304782

AR304782

Site WVOW

Boring No. GW-43D

SHEET 10 OF 11

0940 - Cut + removed of piece casing after washing it

0950 - Pressure washer not working right - not enough pressure / Found hose clogged - unclogged it

1020 - Finished washing casing + removed piece

1040 - Mixed tub grout using: 3 bags cement, ½ bag bentonite, 20 gals water

1055 - Poured grout into hole thru tremmie pipe - pipe is clogged w/ dried grout - worked unclogging it

1120 - Poured grout into hole thru tremmie pipe

1130 - Mixed 2nd tub grout - same mix / Poured grout

1140 - Pulled casing (8") to 65' / Washed casing + cut + removed of piece

1150 - Mixed 3rd tub grout - same mix / Poured grout

1210 - Mixed 4th tub grout - same mix / Cut top of PVC off at 2.2'

1220 - Poured grout

1225 - Mixed 5th tub grout - same mix / Poured grout

1235 - Pulled 8" casing to 53' / Washed casing, cut + removed piece

1245 - Mixed 6th tub grout - same mix / Poured grout

1258 - Pulled casing to 37' / Washed casing + removed piece

1305 - Pulled casing to 32' / Washed casing + removed piece

1310 - Pulled casing to 25' / Washed casing + removed piece

1320 - Mixed 7th tub grout - same mix / Poured grout

1325 - Pulled casing to 20' / Washed + removed of piece

1333 - Pulled casing to 15' / Washed + removed of piece

1340 - Poured unused part of 7th tub grout into hole

1345 - Pulled casing to top of hole / Washed casing + removed it

1355 - Mixed 8th tub grout using 2 bags cement, ⅕ bag bentonite, 15 gals water

1400 - Poured grout

1405 - Washed down rig + equipment

1410 - Broke for lunch

1440 - Finished washing equipment

1500 - Began loading equipment on rig

1510 - Mixed 9th tub grout using 2 bags cement - ⅕ bag bentonite, 15 gals water

1520 - Poured grout

1525 - Lowered drilling tower / Continued packing AR804783

1535 - Loaded casing on trailer

3/23/86 DATE

[signature] SIGNED

DLK 4/20 APPROVED

Site WVOW

Boring No. GW-48D

SHEET 11 OF 11

1545 - MOVED RIG OFF HOLE

1555 - PUT PROTECTIVE CASING W/LOCK OVER PVC CASING + CAP

1610 - LEFT SITE

MATERIALS:

20' - 4" PVC SCREEN SCH 40 SLOT 0.020" (2 - 10' SECTIONS)

89.8' - 4" PVC CASING SCH 40 (9 - 10' SECTIONS)

1 - SCREW IN PVC BOTTOM PLUG

1 - SLIP-ON PVC TOP CAP

9 - 100 lb. BAGS No. 4 QUARTZ SAND

2 - 50 lb. BUCKETS BENTONITE PELLETS 3/8" DIA.

GROUT: 25 - 94 lb. BAGS PORTLAND TYPE I CEMENT

2½ - 50 lb. BAGS QUIKGEL BENTONITE MUD

170 GALS WATER

3/23/86
DATE

[signature]
SIGNED

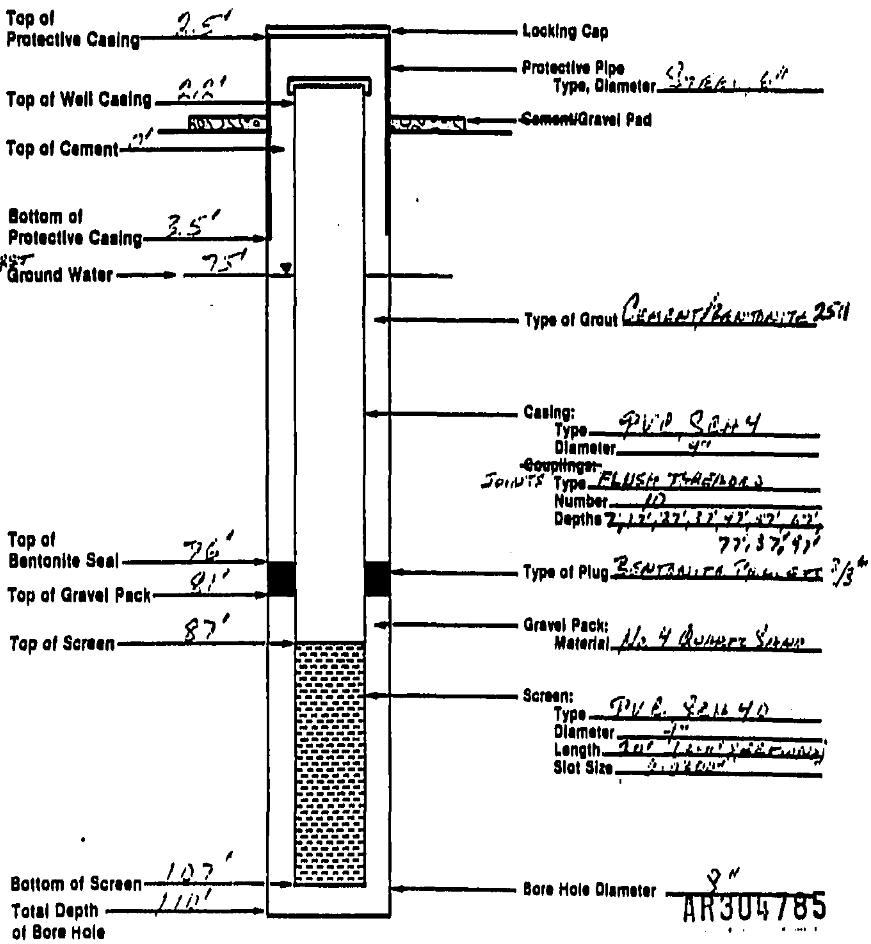
DLK 4/20
APPROVED

AAAP 10/4/86

MONITOR WELL CONSTRUCTION

Logged By: Robert Hazlett
Client: USATHAMA
Drilling Contractor: [illegible]
Location: [illegible]
Driller's Name: [illegible]
Job Number: [illegible]
Well Number: [illegible]
Date/Time: Start [illegible] Finish [illegible]
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



AR304785

NOT TO SCALE

Approved: Dick 4/20

AAAP 10488

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project NWOW

Location of Boring:	EAST SIDE BETWEEN [illegible] 13 + 12, N. DETNT AREA
Water Level	
Time	
Date	

Boring No. 42 Date 3/18/86 Sheet 1 of 2

Type of Boring [illegible] Rig CABLE TOOL

Casing used PVC Size 4" Drilling mud used NONE

Boring begun 3/18/86 Boring completed 3/19/86

Ground Elevation ______ referred to ______ Datum

Field Party: R. HAZLETT; [illegible] PATTERSON; [illegible] AUSTIN

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
						CL	0		SANDY-CLAY w/~30% FINE SAND; BROWN; HIGHLY PLASTIC; LOOSE; MOIST; ALLUVIUM.
						CL			TOP 3" SANDY CLAY w/~[illegible] SAND, THIS GRADES INTO A WELL GRADED CLAYEY GRAVEL w/~[illegible] [illegible] FINE SAND & ~[illegible] GRAVEL W/A SMALLER AMOUNT OF GRAVEL AT BOTTOM OF SAMPLE; 7.5YR 5/6 - STRONG BROWN; THE SANDY CLAY IS HIGHLY PLASTIC & GRAVEL IS [illegible] PLASTIC; LOOSE; WET; A 1" BLACK LAYER [illegible] AT ~6'; ALLUVIUM.
	1	5-6.5'			1.2'	GC	5		
									TOP 3" OF SAMPLE IS CLAYEY GRAVEL AS ABOVE SAMPLE. THIS GRADES INTO A POORLY GRADED SAND W/FEW FINES, ~10% SILT + SOME FINE GRAVEL ~25%; 7.5YR 3/4 - DK. BROWN; NOT PLASTIC; LOOSE; WET; THERE IS A DK. BROWN/BLACK LAYER AT ~11' WHICH MAY BE ORGANICS IN SAND, IT HAS MORE SILT BUT IS NOT PLASTIC; ALLUVIUM.
	2	10-11.5'			1.5'	SW	10		
									FAT CLAY GRADING [illegible] + DK BROWN [illegible] LITTLE [illegible] SAND; 7.5YR 4/4 - BROWN TO DK BROWN; HIGHLY PLASTIC, LOOSE, MOIST; ALLUVIUM.
	3	15-16.5'			1.0	CH	15		
									INTERBEDDED CLAY W/LITTLE SILT ~[illegible]% AND [illegible] SAND W/[illegible] SILT; 10YR 4/4 - DK YELLOWISH BROWN CLAY [illegible] SAND NOT PLASTIC; LOOSE, MOIST; ALLUVIUM.
	4	20-21.5'			1.5'	CL/SM	20		

Signed Robert C. Hazlett Date 3/18/86

Approved D. Kreun Date 8Apr86

AR304786

AAAP 10/4/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 84604

Client USATHAMA

Project UVOW

Location of Boring:	
Water Level	
Time	
Date	

Boring No. 49 Date 3/19/86 Sheet 2 of 4

Type of Boring ______ Rig ______

Casing used ______ Size ______ Drilling mud used ______

Boring begun ______ Boring completed ______

Ground Elevation ______ referred to ______ Datum

Field Party: ______

Depth of Casing, Ft.	Sample No.	Sample Depth from to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION — Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
									Bottom 4" well graded fine sand w/~20% silt; 7.5YR 5/8 - strong brown; low plasticity; loose; moist; [illegible]; alluvium.
									Poorly graded fine sand & silt w/~25% silt; 10YR 4/3 - brown to dk brown; low plasticity; loose; wet; dk brown 4" layer [illegible] at 26' and [illegible] brown layer (4") [illegible] that, all same composition; alluvium.
	5	25-26.5'			1.5'	SM	25		
									Poorly graded fine sand w/~15% silt; 10YR 4/6 - dk yellow brown; non plastic; loose; wet; [illegible] thin (1/2") dark [illegible] layer in bottom of sample; alluvium.
	6	30-31.5'			0.8'	SM	30		
									Fat clay w/ little or no silt or sand; 2.5Y 5/1 - gray; highly plastic; [illegible]; [illegible] moist; [illegible]; alluvium.
	7	35-36.5'			1.5'	CH	35		
							BOH		Bottom of hole - 36.5'

AR304787

Signed Robert C. Hallet Date 3/19/86

Approved David [illegible] Date 8Apr86

Site WVDW

Boring No. GW-49

SHEET 3 OF 4

3/18/86 — Water Level

1550 - ARRIVED AT SITE - PREPARED TO DRILL
1630 - DROVE CASING* TO START HOLE
1637 - DROVE HOLE* TO 5' / BAILED HOLE — +20/-15
1651 - DROVE SAMPLE 5-6.5'
1653 - DROVE TO 10' / BAILED HOLE
1702 - DROVE SAMPLE 10-11.5'
1704 - DROVE HOLE TO 12' / BAILED HOLE
1715 - CASING SANK INTO HOLE HAD TO RETRIEVE IT
1730 - DROVE CASING TO 10'
1740 - DROVE HOLE TO 15' / BAILED HOLE — +20/-20
1755 - DROVE SAMPLE 15-16.5'
1800 - DROVE TO 20' / BAILED HOLE — +10/-10
1810 - DROVE SAMPLE 20-21.5'
1813 - DROVE CASING TO 25'
1820 - SHUT DOWN RIG FOR DAY
1840 - LEFT SITE FOR DAY

3/19/86

0740 - ARRIVED AT SITE - PREPARED TO DRILL
0753 - ADDED CASING (7'11") / DROVE CASING TO 30'
0802 - DROVE HOLE TO 30' / BAILED HOLE — +10/-10
0809 - DROVE SAMPLE 30-31.5'
0811 - DROVE CASING TO 35' / DROVE HOLE TO 35' / BAILED HOLE — +10/-15
0825 - DROVE SAMPLE 35-36.5'
0831 - BEGAN PLACING PVC CASING IN HOLE STARTING WITH
(+ Bottom) 15' SCREEN (SLOT 0.020") (10' THEN 5' SECTION) THEN 25'
PVC CASING - HOLD CASING AT 34' - HOLE BOTTOM 35'
0840 - POURED 3 BAGS SAND / PULLED CASING TO 30' - HAD TO
ADD 45 GALS WATER TO KEEP SCREEN FROM FLOATING OUT
0855 - ADDED 1 BAG SAND / PULLED CASING TO 25' - REMOVED PIECE
0912 - POURED 3 BAGS SAND / PULLED CASING TO 18' - REMOVED PIECE
0925 - ADDED 1/2 BAG SAND / PULLED CASING TO 14' / POURED 1/4 BAG [illegible]
0932 - MEASURED TO TOP SAND - 14' / USED 7 3/4 BAGS SAND
0935 - KNOCKED [illegible] ON TOP OF PVC + INTO HOLE - HAD TO [illegible]
1000 - CUT CAP OUT OF HOLE, [illegible] THREADS [illegible] PVC + [illegible]

* "DROVE HOLE" REFERS TO DRILLING HOLE

"DROVE CASING" REFERS TO PUTTING CASING IN GROUND TO HOLD HOLE OPEN

3/19/86
DATE

[illegible]
SIGNED

David [illegible] 8Apr86
APPROVED

B-99

AR304788

Site LIV [illegible]
Boring No. [illegible]-49

SHEET 4 OF 4

WATER USED

1003 - Poured 3 bucket bentonite pellets (3/8" dia).
1006 - Pulled casing out top of hole / [illegible] casing
1008 - Bentonite pellets stuck to steel casing + PVC - pulled PVC out w/ casing
1015 - Pulled all PVC out of hole, [illegible] to work cap out of steel casing
1035 - Got cap out of casing - began putting steel casing back into hole down to 30' / [illegible] hole. *15 gals
1041 - Added casing / drove hole + casing to 37' / [illegible] hole *25
1107 - Add casing / drove hole + casing to 34' / [illegible] hole *20/+15
1135 - Finished drilling hole + casing to 34' / [illegible] PVC casing w/ pressure washer
1150 - Put PVC in hole - same order
1210 - Pour 1½ bags sand in hole
1235 - More sand [illegible] - [illegible] it
1240 - Break for lunch
1300 - Added 3 bags sand / pulled casing to 27' + [illegible] it + removed
1310 - Pulled casing to 20' / [illegible] + removed it
1317 - Poured 2½ more bags sand - top at 13.5' - used 7 bags sand
1320 - Poured 1 bucket bentonite pellets
1323 - Pulled casing to 10' / [illegible] casing / removed it
1335 - Poured ½ bucket bentonite / top of seal at 8'
1337 - Pulled casing out top of hole [illegible] it
1341 - Mixed [illegible] grout using: 3 bags cement ½ bag [illegible], 30 gals water
1348 - Poured grout / Mixed [illegible] w/ [illegible] cement ½ bag [illegible], 15 gals water
1355 - Poured grout / Began washing down rig + equipment / Began [illegible] rig, lowering drill tower, preparing to leave site
1410 - Cut off PVC to 2.8' - put protective casing over PVC
1435 - Pulled rig off site / waiting for bulldozer to pull it out
1450 - Left site

Materials: 15' - 4" PVC screen, Sch 40, Slot 0.020"; 21.2' - 4" PVC casing;
1 - screw-in PVC bottom plug; 1 - slip-on PVC top cap
14¾ (7)* 100 lb bags [illegible] quartz sand; 4½ (1½)* bentonite pellets
Grout: 5 - 94 lb. bags Portland Type I cement
½ - 50 lb. bag Quik-Gel bentonite mud; 35 gals water

3/19/86
DATE

[signature]
SIGNED

[signature]
APPROVED

*Due to problems with bentonite, sand and bentonite pellets had to be put in twice, amount used in final well installation shown

B-100

AR304789

AAP 10/4/86

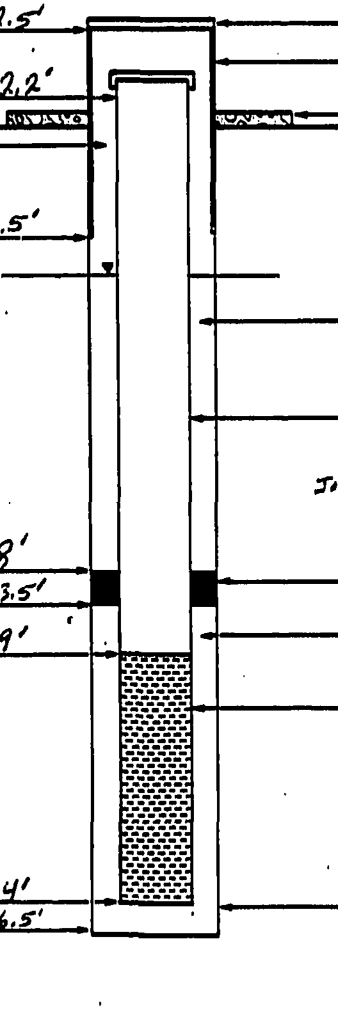
MONITOR WELL CONSTRUCTION

Logged By: Robert C. Hazlett
Drilling Contractor: Bowser-Morner
Driller's Name: Sieberter Patterson
Well Number: GW-44

Client: USATHAMA
Location: WVOW
Job Number: 84604
Date/Time: Start 3/13 Finish 3/19/86

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing 2.5'
Top of Well Casing 2.2'
Top of Cement 0'
Bottom of Protective Casing 3.5'
First Ground Water
Top of Bentonite Seal 8'
Top of Gravel Pack 13.5'
Top of Screen 19'
Bottom of Screen 34'
Total Depth of Bore Hole 36.5'

Locking Cap
Protective Pipe Type, Diameter Steel, 6"
~~Cement~~/Gravel Pad
Type of Grout Cement/Bentonite 1:20
Casing:
Type PVC Sch 40
Diameter 4"
~~Couplings:~~ Joint
Type Flush Threaded
Number 4
Depths ~~5', 10', 20', 25'~~ 4' 9' 19' 24' BLK.
Type of Plug Bentonite Pellets 3/8"
Gravel Pack: Material No. 4 Quartz Sand
Screen:
Type PVC Sch 40
Diameter 4"
Length 15' (10' + 5' sections)
Slot Size 0.0250"
Bore Hole Diameter

AR304790

NOT TO SCALE

DeKrer 8 Nov 86

ENVIRONMENTAL SCIENCE
AND ENGINEERING, INC.

April 8, 1986
ESE No. 84-604-0800-2120

Commander
U.S. Army Toxic and Hazardous
Materials Agency
ATTN: AMXTH-IR (Mr. John F.C. Sanda)
Bldg. E4435
Aberdeen Proving Ground, MD 21010-5401

Re: Contract DAAK11-83-D-0007, Task Order 0004, Delivery Order 0005, West Virginia Ordnance Works Environmental Survey, Submission of Field Drilling Logs

Dear Mr. Sanda:

I have enclosed the original field drilling logs for the following wells:

GW 43
GW 45
GW 45D
GW 44
GW 46
GW 49

Please contact either Mr. Robert Hazlett or me if you have any questions.

Sincerely,

David L. Kraus

David L. Kraus
Task Manager

DLK/dlk

Enclosures

cc: AMXTH-IR, Mr. R.B. Turkeltaub (w/o enclosures)
R. Hazlett
Project file

AR304791

P.O. Box ESE Gainesville, Florida 32602 904/332-3318 TWX 810-825-6310

ESE

AN RSM COMPANY

ENVIRONMENTAL SCIENCE
AND ENGINEERING, INC.

April 22, 1986
84-604-0705-2120

Commander
U.S. Army Toxic and Hazardous Materials Agency
ATTN: AMXTH-IR (Mr. John F.C. Sanda)
Edgewood Area, Bldg. E4435
Aberdeen Proving Ground, MD 21010-5401

Re: Contract DAAK11-83-D-0007, Delivery Order 0005,
West Virginia Ordnance Works (WVOW), Environmental Survey,
Field Drilling Log Submittal

Dear Mr. Sanda:

I have enclosed the original field drilling logs for the following wells:

GW27D	(Abandoned borehole)
GW27D	(Abandoned borehole #2)
GW27D	(Completed well)
GW47	(Abandoned borehole)
GW47	(Completed well)
GW48D	
OW32S	

You should now have the field drilling logs for all wells drilled in the WVOW Phase II field investigation. Please contact either Mr. Robert Hazlett or me if you have any questions.

Sincerely,

D. L. Kraus / tsw

David L. Kraus
Task Manager

DLK/tsw

Enclosure

cc: AMXTH-IR, Mr. R.B. Turkeltaub (w/o enclosures)
R.C. Hazlett
Project file

AR304792

GENERAL LEGEND - TERMINOLOGY USED IN WVOW FIELD DRILLING LOGS

Consistency - Density

Soft = Loose

Stiff = Medium dense

Hard = Dense

-For wells 43, 45, 45D, 46, 49, 47

Plasticity

Not plastic

Low plasticity

Moderate plasticity

Highly plastic

-All wells

Moisture Content

Dry

Very slightly moist

Slightly moist

Moist

Wet = saturated

-All wells

AR304793

APPENDIX C--PHASE II

CHEMICAL ANALYSES

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CSE SAMPLES
COLLECTED FROM LOCATION: P1F (SITE TYPE - POND)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	1198.8	1.97	04/25/86	D2	NB	LT	.50000000	UGG
					13DNB	LT	.20000000	UGG
					135TNB	LT	1.59999999	UGG
					24DNT	LT	.10000000	UGG
					246TNT	LT	.10000000	UGG
					26DNT	LT	.10000000	UGG

AR304795

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CSE SAMPLES
COLLECTED FROM LOCATION: P1F2 (SITE TYPE - POND)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	1198.8	1.97	04/24/86	D2	NB	LT	.50000000	UGG
					130NB	LT	.20000000	UGG
					135TNB	LT	1.59999999	UGG
					24DNT	LT	.10000000	UGG
					246TNT	LT	.10000000	UGG
					26DNT	LT	.10000000	UGG

AR304796

[redacted]

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CSE SAMPLES
COLLECTED FROM LOCATION: P1F3 (SITE TYPE - POND)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	1198.8	1.97	04/24/86	D2	NB	LT	.50000000	UGG
					13DNB	LT	.20000000	UGG
					135TNB	LT	1.59999999	UGG
					24DNT		.26500000	UGG
					246TNT	LT	.10000000	UGG
					26DNT	LT	.10000000	UGG

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CSE SAMPLES
COLLECTED FROM LOCATION: P2F (SITE TYPE - POND)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	1197.8	2.95	04/23/86	D2	NB	LT	.50000000	UGG
					13DNB	LT	.20000000	UGG
					135TNB	LT	1.59999999	UGG
					24DNT	LT	.10000000	UGG
					246TNT	LT	.10000000	UGG
					26DNT	LT	.10000000	UGG

AR304798

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CSE SAMPLES
COLLECTED FROM LOCATION: P2F2 (SITE TYPE - POND)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	1198.8	1.97	04/24/86	D2	NB	LT	.50000000	UGG
					13DNB	LT	.20000000	UGG
					135TNB	LT	1.59999999	UGG
					24DNT		1.16000000	UGG
					246TNT		.35800000	UGG
					26DNT	LT	.10000000	UGG

AR304799

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CSE SAMPLES
COLLECTED FROM LOCATION: P2F3 (SITE TYPE - POND)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	1198.8	1.97	04/24/86	D2	NB	LT	.50000000	UGG
					13DNB	LT	.20000000	UGG
					135TNB	LT	1.59999999	UGG
					24DNT		.50600000	UGG
					246TNT	LT	.10000000	UGG
					26DNT	LT	.10000000	UGG

AR304800

RUN DATE: 20 MAR 87

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL DGHW

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
		.00	34.2	08/13/86	C2	NB	LT	.50000000	UGL
			34.2			13DNB	LT	.20000000	UGL
			34.2			135TNB	LT	2.00000000	UGL
			34.2			24DNT	LT	.30000000	UGL
			34.2			246TNT	LT	.08000000	UGL
			34.2			26DNT	LT	.80000000	UGL
			34.2		K8	NIT	LT	10.00000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL EPA01

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
589.4	.0	.00	2.3	04/29/86	C2	NB	LT	.50000000	UGL
			2.3			130NB		.50000000	UGL
			2.3			135TNB	LT	10.00000000	UGI
			2.3			24DNT		6.00000000	UGL
			2.3			246TNT		5.00000000	UGL
			2.3			26DNT	LT	20.00000000	UGL

AR304802

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL EPA02

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
592.2	.0	.00	1.5	04/29/86	C2	NB	LT	5.00000000	UGL
			1.5			13DNB		6.00000000	UGL
			1.5			135TNB		40.00000000	UGL
			1.5			24DNT		200.00000000	UGL
			1.5			246TNT		300.00000000	UGL
			1.5			26DNT		20.00000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL EPA03

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
590.1	.0	.00	2.4	04/29/86	C2	NB	LT	50.00000000	UGL
			2.4			13DNB	LT	20.00000000	UGL
			2.4			135TNB	LT	200.00000000	UGL
			2.4			24DNT		800.00000000	UGL
			2.4			246TNT		2000.00000000	UGL
			2.4			26DNT		200.00000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL EPA04

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
593.9	.0	.00	17.5	04/29/86	C2	NB	LT	.50000000	UGL
			17.5			130NB	LT	10.00000000	UGL
			17.5			135TNB	LT	10.00000000	UGL
			17.5			24DNT		50.00000000	UGL
			17.5			246TNT		2.00000000	UGL
			17.5			26DNT	LT	40.00000000	UGL

AR304805

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW22

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	63.1	14.99	63.3	04/27/86	C2	NB	LT	.50000000	UGL
			63.3			13DNB	LT	.20000000	UGL
			63.3			135TNB	LT	2.00000000	UGL
			63.3			24DNT	LT	.30000000	UGL
			63.3			246TNT	LT	.08000000	UGL
			63.3			26DNT	LT	.80000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW22D

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	98.3	14.99	98.4	04/26/86	C2	NB	LT	.50000000	UGL
			98.4			130NB	LT	.20000000	UGL
			98.4			135TNB	LT	2.00000000	UGL
			98.4			24DNT	LT	.30000000	UGL
			98.4			246TNT	LT	.08000000	UGL
			98.4			26DNT	LT	.80000000	UGL

AR304807

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW231

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	17.0	14.99	17.0	04/26/86	C2	NB	LT	.50000000	UGL
			17.0			130NB		.70000000	UGL
			17.0			135TNB	LT	2.00000000	UGL
			17.0			24DNT		20.00000000	UGL
			17.0			246TNT		1.00000000	UGL
			17.0			26DNT		4.00000000	UGL

AR304808

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW23S

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	9.5	10.01	9.5	04/26/86	C2	NB	LT	.50000000	UGL
			9.5			13DNB		.59999999	UGL
			9.5			135TNB	LT	2.00000000	UGL
			9.5			24DNT		4.00000000	UGL
			9.5			246TNT		.59999999	UGL
			9.5			26DNT		2.00000000	UGL

AR304809

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CGW SAMPLES
COLLECTED FROM LOCATION: GW27 (SITE TYPE - WELL)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
609.4	571.0	38.39	04/28/86	C2	NB	LT	5.00000000	UGL
					13DNB	LT	2.00000000	UGL
					135TNB		30.00000000	UGL
					24DNT		7.00000000	UGL
					246TNT		20.00000000	UGL
					26DNT	LT	8.00000000	UGL
		38.39	08/11/86	C2	NB	LT	.50000000	UGL
					NB	LT	.50000000	UGL
					NB	LT	.50000000	UGL
					NB	LT	.50000000	UGL
					13DNB		.89999999	UGL
					13DNB		.50000000	UGL
					13DNB	LT	1.00000000	UGL
					13DNB		.89999999	UGL
					135TNB		40.00000000	UGL
					135TNB		30.00000000	UGL
					135TNB		20.00000000	UGL
					135TNB		30.00000000	UGL
					24DNT		4.00000000	UGL
					24DNT		6.00000000	UGL
					24DNT		5.00000000	UGL
					24DNT		6.00000000	UGL
					246TNT		10.00000000	UGL
					246TNT		20.00000000	UGL
					246TNT		30.00000000	UGL
					246TNT		30.00000000	UGL
					26DNT		5.00000000	UGL
					26DNT		2.00000000	UGL
					26DNT	LT	4.00000000	UGL
					26DNT	LT	8.00000000	UGL
				K8	NIT		1180.00000000	UGL
					NIT		1159.99998474	UGL
					NIT		1200.00000000	UGL
					NIT		1239.99998474	UGL
		38.39	08/12/86	C2	NB	LT	.50000000	UGL
					NB	LT	.50000000	UGL
					13DNB		.89999999	UGL
					13DNB		.89999999	UGL
					135TNB		30.00000000	UGL
					135TNB		40.00000000	UGL
					24DNT		5.00000000	UGL
					24DNT		6.00000000	UGL
					246TNT		20.00000000	UGL
					246TNT		20.00000000	UGL
					26DNT	LT	8.00000000	UGL
					26DNT	LT	8.00000000	UGL
				K8	NIT		1230.00000000	UGL
					NIT		1219.99998474	UGL

AR304810

38.39	08/13/86	C2	NB	LT	.50000000	UGL
			13DNB		.70000000	UGL
			135TNB		30.00000000	UGL
			24DNT		5.00000000	UGL
			246TNT		20.00000000	UGL
			26DNT	LT	8.00000000	UGL
		K8	NIT		1200.00000000	UGL

AR304811

RUN C 30 MAR 87

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CGW SAMPLES
COLLECTED FROM LOCATION: GW270 (SITE TYPE - WELL)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
610.4	515.3	95.14	04/28/86	C2	NB	LT	.50000000	UGL
					13DNB		4.00000000	UGL
					135TNB		7.00000000	UGL
					24DNT		.50000000	UGL
					246TNT		5.00000000	UGL
					26DNT	LT	.80000000	UGL
		95.14	08/11/86	C2	NB	LT	.50000000	UGL
					NB	LT	.50000000	UGL
					NB	LT	.50000000	UGL
					NB	LT	.50000000	UGL
					13DNB		5.00000000	UGL
					13DNB		3.00000000	UGL
					13DNB		2.00000000	UGL
					13DNB		2.00000000	UGL
					135TNB		30.00000000	UGL
					135TNB		30.00000000	UGL
					135TNB		50.00000000	UGL
					135TNB		20.00000000	UGL
					24DNT		.80000000	UGL
					24DNT		.59999999	UGL
					24DNT		.70000000	UGL
					24DNT		.70000000	UGL
					246TNT		8.00000000	UGL
					246TNT		7.00000000	UGL
					246TNT		7.00000000	UGL
					246TNT		10.00000000	UGL
					26DNT	LT	4.00000000	UGL
					26DNT	LT	4.00000000	UGL
					26DNT	LT	4.00000000	UGL
					26DNT	LT	4.00000000	UGL
				K8	NIT		507.99999619	UGL
					NIT		724.00000000	UGL
					NIT		449.00000000	UGL
					NIT		458.99999619	UGL
		95.14	08/12/86	C2	NB	LT	.50000000	UGL
					NB	LT	.50000000	UGL
					13DNB		2.00000000	UGL
					13DNB		2.00000000	UGL
					135TNB		30.00000000	UGL
					135TNB		30.00000000	UGL
					24DNT		.89999999	UGL
					24DNT		.50000000	UGL
					246TNT		5.00000000	UGL
					246TNT		6.00000000	UGL
					26DNT	LT	4.00000000	UGL
					26DNT		1.00000000	UGL
				K8	NIT		552.99999237	UGL
					NIT		518.99999237	UGL

AR304812

95.14	08/13/86	C2	NB	LT	.50000000	UGL
			13DNB		1.00000000	UGL
			135TNB	LT	2.00000000	UGL
			24DNT		.59999999	UGL
			246TNT		2.00000000	UGL
			26DNT	LT	4.00000000	UGL
		K8	NIT		544.99999237	UGL

AR304813

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW28

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	16.5	15.03	5.7	04/28/86	C2	NB	LT	.50000000	UGL
			5.7			13DNB	LT	.20000000	UGL
			5.7			135TNB	LT	2.00000000	UGL
			5.7			24DNT	LT	.30000000	UGL
			5.7			246TNT	LT	.08000000	UGL
			5.7			26DNT	LT	80000000	UGL

AR304814

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW29

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200 8	37.9	14.99	38.1	04/24/86	C2	NB	LT	.50000000	UGL
			38.1			13DNB	LT	.20000000	UGL
			38.1			135TNB	LT	2.00000000	UGL
			38.1			24DNT	LT	.30000000	UGL
			38.1			246TNT	LT	.08000000	UGL
			38.1			26DNT	LT	.80000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW30

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	30.5	10.01	30.5	04/28/86	C2	NB	LT	.50000000	UGL
			30.5			13DNB	LT	.20000000	UGL
			30.5			135TNB		10.00000000	UGL
			30.5			24DNT	LT	3.00000000	UGL
			30.5			246TNT		2.00000000	UGL
			30.5			26DNT		2.00000000	UGL

AR304816

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW31

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	36.5	19.98	36.4	04/24/86	C2	NB	LT	.50000000	UGL
			36.4			13DNB	LT	.20000000	UGL
			36.4			135TNB	LT	2.00000000	UGL
			36.4			24DNT	LT	.30000000	UGL
			36.4			246TNT	LT	.08000000	UGL
			36.4			26DNT	LT	.80000000	UGL

AR304817

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW32

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200 8	30.5	14.99	13.6	04/27/86	C2	NB	LT	.50000000	UGL
			13.6			130NB	LT	.20000000	UGL
			13.6			135TNB	LT	2.00000000	UGL
			13.6			24DNT	LT	.30000000	UGL
			13.6			246TNT	LT	.08000000	UGL
			13.6			26DNT	LT	.80000000	UGL

AR304818

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW32D

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	58.5	15.03	65.9	04/23/86	C2	NB	LT	.50000000	UGL
			65.9			13DNB	LT	.20000000	UGL
			65.9			135TNB	LT	2.00000000	UGL
			65.9			24DNT	LT	.30000000	UGL
			65.9			246TNT	LT	.08000000	UGL
			65.9			26DNT	LT	.80000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW33

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	15.0	14.99	15.0	04/29/86	C2	NB	LT	.50000000	UGL
			15.0			13DNB	LT	.20000000	UGL
			15.0			135TNB	LT	10.00000000	UGL
			15.0			24DNT	LT	.30000000	UGL
			15.0			246TNT	LT	.20000000	UGL
			15.0			26DNT	LT	.80000000	UGL

AR304820

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW34

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	24.5	20.01	19.5	04/25/86	C2	NB	LT	.50000000	UGL
			19.5			13DNB	LT	.20000000	UGL
			19.5			135TNB	LT	2.00000000	UGL
			19.5			24DNT	LT	.30000000	UGL
			19.5			246TNT	LT	.08000000	UGL
			19.5			26DNT	LT	.80000000	UGL

AR304821

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW34D

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	106.5	14.99	106.5	04/25/86	C2	NB	LT	.50000000	UGL
			106.6			13DNB	LT	.20000000	UGL
			106.6			135TNB	LT	2.00000000	UGL
			106.6			24DNT	LT	.30000000	UGL
			106.6			246TNT	LT	.08000000	UGL
			106.6			26DNT	LT	.80000000	UGL

AR304822

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW36D

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	85.3	15.03	92.8	04/24/86	C2	NB	LT	.50000000	UGL
			92.8			13DNB	LT	.20000000	UGL
			32.8			135TNB	LT	2.00000000	UGL
			92.8			24DNT	LT	.30000000	UGL
			92.8			246TNT	LT	.08000000	UGL
			92.8			26DNT	LT	.80000000	UGL

AR304823

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW40

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	29.8	14.99	10.2	04/26/86	C2	NB	LT	.50000000	UGL
			10.2			13DNB	LT	.20000000	UGL
			10.2			135TNB	LT	2.00000000	UGL
			10.2			24DNT	LT	.30000000	UGL
			10.2			246TNT	LT	.08000000	UGL
			10.2			26DNT	LT	.80000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW400

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	80.5	19.98	27.7	04/26/86	'C2	NB	LT	.50000000	UGL
			27.7			13DNB	LT	.20000000	UGL
			27.7			135TNB	LT	2.00000000	UGL
			27.7			24DNT	LT	.30000000	UGL
			27.7			246TNT	LT	.08000000	UGL
			27.7			26DNT	LT	.80000000	UGL

AR304825

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CGW SAMPLES
COLLECTED FROM LOCATION: GW41 (SITE TYPE - WELL)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
607.5	580.0	27.49	04/28/86	C2	NB	LT	.50000000	UGL
					13DNB		.80000000	UGL
					135TNB	LT	10.00000000	UGL
					24DNT		7.00000000	UGL
					246TNT		4.00000000	UGL
					26DNT		3.00000000	UGL
		27.49	08/13/86	C2	NB	LT	.50000000	UGL
					13DNB	LT	.20000000	UGL
					135TNB	LT	2.00000000	UGL
					24DNT		7.00000000	UGL
					246TNT		3.00000000	UGL
					26DNT	LT	8.00000000	UGL
				K8	NIT		961.00000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW42

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
1200.8	16.8	15.03	5.8	04/25/86	C2	NB	LT	.50000000	UGL
			5.8			13DNB	LT	.20000000	UGL
			5.8			135TNB	LT	2.00000000	UGL
			5.8			24DNT	LT	.30000000	UGL
			5.8			246TNT	LT	.08000000	UGI
			5.8			26DNT	LT	.80000000	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW43

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
612.9	16.8	.00	27.5	04/28/86	C2	NB	LT	.50000000	UGL
			27.5			13DNB	LT	.20000000	UGL
			27.5			135TNB	LT	2.00000000	UGL
			27.5			24DNT		2.00000000	UGL
			27.5			246TNT		3.00000000	UGL
			27.5			26DNT	LT	.80000000	UGL

AR304828

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW44

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
608 6	16.8	.00	12.6	04/28/86	C2	NB	LT	.50000000	UGL
			12.6			13DNB	LT	.20000000	UGL
			12.6			135TNB	LT	10.00000000	UGL
			12.6			24DNT	LT	.30000000	UGL
			12.6			246TNT	LT	.20000000	UGL
			12.6			26DNT	LT	.80000000	UGL
			12.6	08/13/86		NB	LT	.50000000	UGL
			12.6			13DNB		2.00000000	UGL
			12.6			135TNB	LT	2.00000000	UGL
			12.6			24DNT	LT	.30000000	UGL
			12.6			246TNT	LT	.08000000	UGL
			12.6			26DNT	LT	.80000000	UGL
			12.6		K8	NIT		90.39999962	UGL

RUN DATE: 30 MAR 87

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CGW SAMPLES
COLLECTED FROM LOCATION: GW45 (SITE TYPE - WELL)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
612.2	564.6	47.57	04/28/86	C2	NB	LT	5.00000000	UGL
					13DNB	LT	2.00000000	UGL
					135TNB		90.00000000	UGL
					24DNT		7.00000000	UGL
					246TNT		30.00000000	UGL
					26DNT		20.00000000	UGL
		47.57	08/14/86	C2	NB	LT	.50000000	UGL
					13DNB	LT	.20000000	UGL
					135TNB		100.00000000	UGL
					24DNT		1.00000000	UGL
					246TNT		40.00000000	UGL
					26DNT		20.00000000	UGL
				KB	NIT		2509.99996948	UGL

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW45D

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
- 612.0	16.8	.00	98.4	04/26/86	C2	NB	LT	.50000000	UGL
			98.4			13DNB		2.00000000	UGL
			98.4			135TNB	LT	2.00000000	UGL
			98.4			24DNT	LT	.30000000	UGL
			98.4			246TNT		.30000000	UGL
			98.4			26DNT	LT	.80000000	UGL
			98.4	08/14/86		NB	LT	.50000000	UGL
			98.4			13DNB		7.00000000	UGL
			98.4			135TNB	LT	2.00000000	UGL
			98.4			24DNT	LT	.30000000	UGL
			98.4			246TNT	LT	.08000000	UGL
			98.4			26DNT	LT	.80000000	UGL
			98.4		KB	NIT		14.69999993	UGL

AR304831

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW46

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
607.6	16.8	.00	47.6	04/28/86	C2	NB	LT	.50000000	UGL
			47.6			130NB		.40000000	UGL
			47.6			135TNB	LT	2.00000000	UGL
			47.6			24DNT	LT	.30000000	UGL
			47.6			246TNT		1.00000000	UGL
			47.6			26DNT	LT	.80000000	UGL

AR304832

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF CGW SAMPLES
COLLECTED FROM LOCATION: GW47 (SITE TYPE - WELL)

SURFACE ELEVATION (FEET)	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
610.6	554.2	56.43	04/28/86	C2	NB	LT	5.00000000	UGL
					13DNB		2.00000000	UGL
					135TNB	LT	20.00000000	UGL
					24DNT		20.00000000	UGL
					246TNT		5.00000000	UGL
					26DNT	LT	8.00000000	UGL
		56.43	08/13/86	C2	NB	LT	.50000000	UGL
					13DNB		1.00000000	UGL
					135TNB	LT	20.00000000	UGL
					24DNT		20.00000000	UGL
					246TNT		6.00000000	UGL
					26DNT	LT	8.00000000	UGL
				K8	NIT		4079.99996948	UGL

AR304833

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW4BD

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
534.7	16.8	.00	97.1	04/27/86	C2	NB	LT	.50000000	UGL
			97.1			130NB		.89999999	UGL
			97.1			135TNB	LT	2.00000000	UGL
			97.1			24DNT	LT	.30000000	UGL
			97.1			246TNT		.08000000	UGL
			97.1			26DNT	LT	.80000000	UGL
			97.1	08/13/86		NB	LT	.50000000	UGL
			97.1			13DNB		8.00000000	UGL
			97.1			135TNB	LT	2.00000000	UGL
			97.1			24DNT	LT	.30000000	UGL
			97.1			246TNT	LT	.08000000	UGL
			97.1			26DNT	LT	.80000000	UGL
			97.1		K8	NIT		21.99999976	UGL

AR304834

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL GW49

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
595.9	16.8	.00	26.5	04/28/86	C2	NB	LT	.50000000	UGL
			26.5			13DNB	LT	.20000000	UGL
			26.5			135TNB	LT	2.00000000	UGL
			26.5			24DNT	LT	.30000000	UGL
			26.5			246TNT	LT	.08000000	UGL
			26.5			26DNT	LT	.80000000	UGL

AR304835

WEST VIRGINIA ORDNANCE WORKS
ANALYTICAL RESULTS OF GROUND WATER SAMPLES
COLLECTED FROM WELL SIW6

SURFACE ELEVATION (FEET)	MID SCREEN DEPTH (FEET)	SCREEN LENGTH (FEET)	SAMPLE DEPTH (FEET)	SAMPLE DATE	TEST METHOD NUMBER	COMPOUND		CONCENTRATION	UNITS
		.00	25.7	04/26/86	C2	NB	LT	.50000000	UGL
			25.7			13DNB		.89999999	UGL
			25.7			135TNB	LT	2.00000000	UGL
			25.7			24DNT	LT	.30000000	UGL
			25.7			246TNT		.20000000	UGL
			25.7			26DNT	LT	.80000000	UGL

AR304836

APPENDIX D--PHASE II

LAND SURVEY DATA

NOTE: Copies in this appendix are the best quality available.

AR304838

Phone: (614) 446-8221
446-7004
446-1074

Joseph L. Leach, Pres.
Barbara J. Leach, V. Pres.

JOE LEACH, INC.

P.O. BOX 212
GALLIPOLIS, OHIO 45631

April 23, 1986

Mr. Robert C. Hazlett
ESE
P.O. Box ESE
Gainesville, Florida 32602

RE: Survey Work
W.Va. Ordnance Works

Dear Mr. Hazlett:

Enclosed are two (2) copies of survey work performed as per your February 28, 1986 request for 10 new Monitoring Wells and resurvey of 4 EPA Wells.

If you have any questions please advise.

Very truly yours,

Joseph L. Leach, President

Encl: 2 copies

STATE OF WEST VIRGINIA
JOSEPH L
LEACH
L.S. 183
REGISTERED
SURVEYOR

AR304839

π JLC
Ø SER

4-17-86

Overcast
Breezy
40°

Figure #4

[illegible] = Hub T.P. near Pond #14

BS-TP-FS	ESE Slope Dist.	McClintock Vert	[illegible]	[illegible]	[illegible]	
2-1	408.94	90-40-17			GW 231	(old)
1-2-3	[illegible]	[illegible]	[illegible]	[illegible]	GW 59	[illegible]
			179-59-57	141-43-53	321°43'56"	
1-2-4	[illegible]	[illegible]	[illegible]	01-58-21	GW 225	[illegible]
			179-59-59	181-58-21	1°58'22"	
1-2-5	[illegible]	91 13-36	00-00-00	05-08-58	EPA = 1	(old)
			180-00-01	185-08-56	5°8'57"	
1-2-6	185.7[illegible]	90-51-39	00-00-00	13-36-21	EPA = 2	[illegible])
			180-00-01	193-35-18	13°35'19"	
1-2-7	229.[illegible]	91 41-19	00-00-00	14-20-37	EPA # 3	old)
			180-00-00	194-20-36	14°20'37"	
1-2-8	179.56	91-05-21	00-00-00	255-36-01	GW 48 D	(New)
			180-00-03	75-35-58	255°35'5[illegible]"	
2-9	345.[illegible]	89-48-55			T.P. [illegible] 2 Rd	
1-2-9			00-00-00	46-01-15	46°01'1[illegible]"	
			180-00-03	226-01-12		

AR304840

4-17-86

Figure #4

		McClintic				
2-9-10	60.01	94-48-34	00-00-00	4-45-04	O.W. 34 S	(New)
			180-00-02	184-45-05	4°45'04"	
2-9-11	92.15	91-51-39	00-00-00	93-49-13	EPA #4	(old)
			180-00-01	273-49-09	93°49'11"	
2-9-12	834.43	90-57-29	00-00-00	115-18-06	S.R. intersection	#125
			179-54-56	295-18-01	115°18'06"	
9-13	138.11	85-31-00			T.P.	
2-9-13			00-00-00	158-25-26		
			179-54-58	338-25-32	158°25'25"	
9-13-14	309.72	57-49-58	00-00-00	231-24-23	GW. 17 D	(old)
			180-00-00	51-24-20	231°24'21"	
9-13-15	283.01	59-33-40	00-00-00	227-57-04	GW 43	(New)
			180-00-01	47-57-01	227°57'02"	
13-16	308.97	92-49-44			T.P. GW 23 I	
9-13-16			00-00-00	73-42-36		
			180-00-01	253-42-32	73°42'33"	
13-16-17			00-00-00	81-50-43	T.P.	Closing
			179-59-57	261-50-41	81°50'	

AR304841

4-17-86

OVERCAST
Breezy
40°

Figure #4

McClintic

	B.S.	H.I.	F.S.	Elev.	
B.M. GW 23S	6.73	600.47	•	593.74	Top casing @ mark
GW-48D	—	—	3.70	596.77	" "
G.W-48D			5.73	594.74	ground
EPA 1			7.19	593.29	Top casing @ mark
EPA 1			11.11	589.36	ground
EPA 2			4.63	595.84	Top casing @ mark
EPA 2			8.25	592.22	ground
EPA 3			7.50	592.97	Top casing @ mark
EPA 3			10.38	590.09	ground
B.M. G.W-23S			6.73	593.74	Top casing @ mark
Bm GW 23I	7.29	600.62		595.33	Top casing @ mark
EPA 4			3.74	596.88	Top casing @ mark
EPA 4			6.71	593.91	ground
OW 34S			6.13	594.49	Top casing @ mark
O.W 34S			7.65	592.97	ground
BM GW 23I			7.19	595.33	Top casing @ mark

4.10 F.S.
[illegible] mark [illegible]

4-17-86

Figure # 4

	B.S.	H.I.	F.S.	Elev.	
		McQ[illegible]			
BM GW 120	1.36	615.79		614.43	Top casing @ mark
GW 43			0.72	615.07	Top casing @ mark
GW 43			2.89	612.90	ground
BM GW 120			1.36	614.43	Top casing @ mark
BM GW 221	11.84	600.48		588.64	Top casing @ mark
GW 49			2.37	598.11	Top casing @ mark
GW 45			4.57	595.91	ground
BM GW 220			11.84	588.64	Top casing @ mark

AR304843

4-17-86

McClurkin

Figure #3

19-18	794.83	89-57-02			GW. 42	(old)
18-19-20	66.84	92-29-33	00-00-00 179-59-55	297-47-40 117-47-38	GW. 44 297°47'41"	(new)
18-19-21	1,163.20	90-16-53	00 00-00 179 59-55	10-16-58 10-16-59	GW 27 190°16'58"	(old)
18-19-22	1,112.70	90-09-37	00-00-00 180-00-0?	182-14-03 02-14-00	GW 27 D 182°14'02"	(new)

AR304844

McClintic Wildlife Breezy 40°

Figure # 3

	-BS +	HI.	F.S. -	Elev.	
BM GW 27	2.96	614.50		611.54	Top casing @ mark
GW 27 D			1.73	612.77	Top casing @ mark
GW 27 D			4.07	610.43	ground
GW 44			2.55	610.95	Top casing @ mark
GW 44			[illegible]	608.63	ground
BM GW 27			2.96	611.54	Top casing @ mark

AR304845

4-18-86

Survey 65-30 Breezy

Figure #2

	ESF	McClint...	wild...			
24-23	187.99	89-47-32			T.P. Hub	
23-24-25	622.26	89-21-30	00-00-00 180-00-02	263-14-52 83-14-49	GW 47 263°14'50"	(New)
23-24-26	1054.[illegible]	91-22-40	[illegible] 180-00-01	[illegible] 275 33 [illegible]	GW 32D 95°33'10"	(old)
24-27	580.26	89-34-48			T.P. Hub	
23-24-27			00-00-00 179-59-58	335-01-30 155-01-17	335°01'20"	
24-27-28	356.56	91-48-47	00-00-00 179-59-57	99-42-05 279-42-01	GW 46 99°42'05"	(New)
24-27-29	127.40	92-53-24	00-00-00 179-59-55	264-08-40 84-08-38	GW 45 264°08'40"	(new)
24-27-30	139.38	97-46-07	00-00-00 179-59-56	264-47-50 84-47-46	GW 45D 264°47'50"	(new)
33 27-31	417.51	90-34-36			T.P. hub	
24-27-31			00-00-00 180-00-00	349-02-17 169-02-14	349°02'15"	

Old PK # 157 35

AR304846

4-18-86

McClintic Wildlife Sta.

27-31-32	288.25	90-36-13	00-00-00	99-57-05	GW 30
			179-59-55	279-57-09	99°57'14"
28 24 27-31-33			00-00-00	215-56-30	T.P.
			179-56-56	35-56-31	215°56'32"

Figure #2

(old)

Old Pk. #156

4-18-86 Sunny Breezy 70°

Level Loop

Figure 2

	E.S.E.	McClintic [illegible]			
	BS +	H.I.	F.S. −	Elev.	
BS GW 30	3.22	617.28	—	614.056	Top casing @ mark
T.P.#1	6.655	620.99	2.945	614.33	
GW 45			6.59	614.40	Top casing @ mark
GW 45			8.80	612.19	ground
GW 45 D			6.78	614.21	Top casing @ mark
GW 45 C			8.95	612.04	ground
GW 46			11.78	609.71	Top casing @ mark
GW 46			13.42	607.57	ground
T.P.#2	3.603	617.89	6.70	614.29	
BM GW 30			3.83	614.06	Top casing @ mark
BM GW 30	3.83	617.89	—	614.056	Top casing @ mark
T.P.#1	0.325	613.03	5.186	612.70	
T.P.#2	7.151	616.95	3.927	609.20	
GW 47			4.20	612.75	Top casing @ mark
GW 47			6.34	610.61	ground
~~T.P.#3~~	3.86	612.98	7.83	609.12	
T.B.#4	5.34	618.02	0.299	612.68	
BS GW 30			3.96	614.06	Top casing @ mark

AR 300848

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Barbara J. Leach, V. Pres.

JOE LEACH, INC.

P.O. BOX 212
GALLIPOLIS, OHIO 45631

PT #	NORTH	EAST	DESCRITPION	GROUND ELEV.	ELEVATION @ MARK*
1	697,948.1507	1,695,075.0743	HUB		
2	698,273.3281	1,694,827.1450	GW23I		
3	698,099.1662	1,695,505.0276	GW49	595.91	598.11
4	698,014.6299	1,695,010.6574	GW23S		
5	698,011.2479	1,694,992.0216	EPA#1	589.36	593.29
6	698,011.8038	1,694,942.1362	EPA#2	592.22	595.84
7	698,052.9850	1,694,920.5838	EPA#3	590.09	592.97
8	698,414.2654	1,694,938.3513	GW48D	594.74	596.77
9	697,932.0094	1,694,774.9373	NAIL IN RD.		
10	697,990.1687	1,694,788.8438	~~GW34S~~ GW32S D.L.	592.97	594.49
11	697,914.2156	1,694,855.0926	EPA#4	593.91	596.88
12	697,465.3796	1,695,466.7914	RR SPIKE		
13	697,797.7863	1,694,805.6289	HUB		
14	697,555.7683	1,694,612.3632	GW12D		
15	697,566.1654	1,694,643.0197	GW43	612.9	615.07
18	699,936.5348	1,691,589.1600	GW42		
19	700,227.7818	1,692,328.7071	HUB		
20	700,161.4082	1,692,321.3802	GW44	608.63	610.95
21	700,317.8503	1,692,783.0600	GW27		
22	700,363.9228	1,692,718.3030	GW27D	610.43	612.77
23	705,644.8862	1,689,784.9897	HUB		
24	705,603.7163	1,689,601.5645	HUB		
25	706,190.5988	1,689,394.8541	GW47	610.61	612.75
26	704,552.8773	1,689,732.4091	GW32D		
27	705,957.9755	1,690,061.1119	HUB		
28	706,272.8563	1,689,894.2033	GW46	607.57	609.71
29	705,865.6415	1,690,148.6821	GW45	612.19	614.40
30	705,855.8793	1,690,155.7572	GW45D	612.04	614.21

*Top of PVC well casing.

STATE ... EST VIRG...
JOSEPH L
LEACH
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